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PREFACE TO VOL. III.

The utility of a *Journal of Natural History* in Calcutta, can hardly be considered any longer a doubtful question, since we find at the end of the third year of the experiment, sufficient encouragement on the part of the public for its continuance, without any effort to enlist new supporters, further than the regular appearance of each number as it becomes due.

The events, political and mercantile of the past year, have been, it is true, calculated to divert attention from scientific enquiry, and we believe our Journal is the only one of its kind in India, depending on the voluntary labours of correspondents, that has not suffered from the circumstances adverted to. Retirements from India, and other changes in Society, have deprived us of the support of above forty of the original subscribers, yet an almost equal number of new subscribers enable us to continue the work, under the advantage not only of increased experience, but also, we trust, of increased editorial strength.

From this period, we may hope to be assisted in the Editorship of the Journal by Mr. Griffith.

It is hoped, that the increased interest which this arrangement will secure to the work, may also be attended with a proportionate increase to the number of subscribers, which would enable the Editors either to reduce the expense of the work, or to enlarge it materially. It is needless for the Editor to say, that it never was intended that any profit should accrue to himself as remuneration for his trouble.

It is not intended to introduce any change in the form of the Journal; but its pages, we trust, will gradually be made to embrace a wider range of subjects than heretofore.

THE

CALCUTTA JOURNAL

OF

NATURAL HISTORY.

Faraday's Experimental Researches in Electricity.

First and Second Series.*

The marked analogies that subsist between the leading phenomena of Electricity and Magnetism, early suggested the idea of these two powers being intimately connected, and led to many oft-repeated and varied, though long fruitless, efforts to detect the nature and relations of this connection. Numerous distinguished names occur in the records of these unsuccessful attempts, and it is sufficiently remarkable that at least in one instance, that of the celebrated Beccarria, the very verge of that brilliant discovery, on which has been reared the new science of Electro-magnetism, was unconsciously attained. During the progress of his researches, undertaken with the specific intention of investigating the relations of electricity to magnetism, Beccarria observed, that a needle through which he had transmitted an electric shock,

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* We are indebted to Lieut. R. Baird Smith, of the Bengal Engineers, for this interesting analysis of the three first Series of Faraday's Experimental Researches, as we have been to the same accomplished officer for former papers, also on Electricity, which excited considerable interest at the time they were published.—Ed.

acquired a remarkable species of polarity, since instead of placing itself as usual in the magnetic meridian, it exhibited a decided tendency to assume a position transverse to this; so that instead of pointing north and south, it pointed east and west. That he did not follow out this singular fact, proves that he was ignorant of its true value; since its rediscovery, nearly half a century afterwards, by Professor Oersted of Copenhagen, was the first step in that career of discovery, which has conferred immortal honour on that philosopher's name, and has secured for him one of the most honourable niches in the temple of scientific fame. None who had endeavoured to solve the seductive problem we have above alluded to, laboured more assiduously, and perseveringly to this end, than M. Oersted; and although the fundamental fact was originally discovered by him, in a manner almost accidental, it was an accident of which he alone was capable of availing himself, and for the due appreciation of the value of which, his mind had been prepared by a long train of thought and experiment; so that there was in reality no more chance in the discovery, than there is in the process by which, in a happy moment of inspiration, a man solves a difficulty upon which his mind has long been intently fixed. In the year 1820, Oersted announced that the conducting wire, connecting the poles of a galvanic battery, while being traversed by an electric current, acts upon the magnetic needle, and gives origin to a force so acting upon it as to dispose it to take a position *at right angles* to the wire. Intense excitement was created among scientific men by this announcement; verification of Oersted's experiments was made in several countries; and the range of his facts widely extended among the most distinguished of the cultivators of the infant science, to which the name of Electro-magnetism had been assigned were Ampere and Arago in France, and Davy and Faraday in England; and by their united efforts much important and valuable information was elicited. To enter into any of the details of this, forms no part of our present design, save in so far as it may be necessary to ensure a clear apprehension of the views we shall subsequently express; and we may therefore only briefly state at present, that on analysing the experiments of Oersted into their simplest conditions, it appeared as if the conducting wire exerted on the pole of the magnet a kind of force, neither attractive nor repulsive, but *transverse;* and by numerous experiments it was clearly established that the force was really of this perfectly novel and singular nature, a remarkable example of it being exhibited by Mr. Faraday in 1821, wherein the force actually sustained either the wire or the magnet, in a state of constant and rapid revolution about each other. Two theories were proposed in explanation of these phenomena, the one by Oersted, in which the conducting wire was supposed to be made up of an infinite number of minute transverse magnets, having their opposite poles facing each other; and the other devised by M. Ampere, in which the magnet is supposed to be made up of a series of conducting wires in transverse positions. At first sight it seemed a matter of indifference which of the two theories was selected, as both appeared capable of application to the facts: but it was ere long found that the first could not, without certain arbitrary and improbable additions, afford any explanation of *continued* motion in electro-magnetic experiments, while the second explained this, and also the mutual action of magnets on each other, and of conducting wires on each other, cases not contemplated by Ampere in originally devising his theory, and therefore telling strongly in its favour, in the most complete and satisfactory manner. Remarkable experimental evidence for the Amperian theory was farther obtained from the perfect identity of effects produced by spiral conducting wires, or electro-dynamic cylinders as they were called, and common magnets. In common they are influenced by the magnetism of the earth; the same phenomena of attraction, repulsion, and revolution are exhibited by each; the extremities of the cylinder correspond to the poles of the magnet; and two cylinders act upon each other precisely as two magnets do. Hence then the most hypothetical part of the theory of Ampere, the existence within the magnet of spiral currents of electricity, receives the strongest confirmation from actual experiment; and taking into account with this, the profound mathematical evidence in its favour, there cannot be a doubt of its representing truly the constitution of bodies on which their magnetic properties depend, and thus demonstrating that magnetism is nothing more than a peculiar modification of electricity.

While however the genius of Ampere, as displayed both in his consummate skill in analysis, and fertility in experimental resources, successfully proved that magnetism is only a peculiar form of electro-motive action, and that all its phenomena may, by means of this, be imitated correctly, all efforts to shew that the converse of this discovery, or the production of electricity from magnetism was possible, were for a long time fruitless; and it was not till in 1831, when Faraday commenced his masterly course of experimental research on the subject, that any important information was obtained.

These researches present to us one of those remarkable and rare epochs to the history of science, when the discovery of certain grand and novel principles involves an entire remodelling of our ideas on that branch of inductive truth, to which they refer. Viewed as a whole, their most important relation is undoubtedly to the science of chemistry, since the results they exhibit, by proving the entire identity of the forces of affinity and of decomposition on the surest of all evidence, that of the balance and measure, have led to the firm establishment of the electro-chemical theory of the constitution of water. But there are interspersed throughout them, several related, yet at the same time distinct, trains of investigation, that have an interest and a beauty peculiarly their own. These we shall not fail to notice as we progress in our review; and we may remark that the general principles which Faraday has so successfully established, are not merely extensions of pre-existing knowledge, but they are essentially new laws of nature—new provinces added to the domains of science, inviting to extended enquiry, and promising rich returns.

The first and second series of the experimental researches, to which we purpose confining the present article, are devoted to the investigation of certain new and important points in the science of electro-magnetism. They presuppose, on the part of their readers, a somewhat extensive acquaintance with the doctrines of this science; but still there is nothing in them that may not readily be understood, and we shall endeavour, as far as we can, to make an exposition of them clear and explicit. This object is materially facilitated by the lucid style in which the researches are narrated, since that vividness of conception, and steadiness of thought, at all times so characteristic of truly original minds, are, in Faraday's case, accompanied by a corresponding facility of exposition, and command of language, so that his results are invariably presented to the reader in the simplest and most appropriate terms, and illustrated in the most effective, and often engaging manner. He appears to repudiate entirely that mystic style in which many love so suspiciously to clothe their thoughts, and in the purest spirit of philosophy, his sole aim seems to be first to discover, then to expound, the simple and unadorned truth.

So early as the year 1825 Faraday had experimented, but without success, on the induction of electrical currents: from that time forward his mind appears to have been keenly alive to the detection of phenomena relating to this branch of the subject, and a conviction seems to have been ever present with him, that could the key to the discovery but be found, a rich treasure would reward the discoverer. "It appeared very extraordinary," he remarks, "that as every electric current was accompanied by a corresponding intensity of magnetic action at right angles to the current, good conductors of electricity, when placed within the sphere of this action, should not have any current induced through them, or some sensible effect produced, equivalent in force to such a current." These considerations, with their consequence, the hope of obtaining electricity from common magnetism, have stimulated me at various times to investigate experimentally the inductive effect of electric current: the power of induction herein alluded to, may be defined as that property by which electrical currents induced any particular state upon matter in their immediate neighbourhood, and in this general sense it is employed by Faraday throughout his masterly researches.

After several experiments equally unsuccessful with his former efforts, Faraday at length, in 1831, obtained decisive proof of the power of a current of galvanic electricity to induce upon a wire in its vicinity, a certain electrical state, and in a manner very different indeed to his previous expectations. It then appeared that induction took place momentarily, when the contact of the conducting wire with the battery was made, and again when it was broken. But to render this more clear, we shall briefly detail that experiment by which this result, and through it the large train that follows it, were obtained. Two hundred and three feet of copper wire in one length were coiled round a block of wood; other two hundred and three feet of similar wire were interposed as a spiral between the turns of the first coil, and metallic contact everywhere prevented by twine. One of these helices was connected with a galvanometer, and the other with a battery of one hundred pairs of plates, four inches square, with double coppers, and well charged. *When the contact was made,* there was a sudden and very slight effect at the galvanometer, and also a similar slight effect *when the contact with the battery was broken.* But whilst the voltaic current was continuing to pass through the one helix, no galvanometrical appearances nor any effect like induction upon the other helix could be perceived, although the active power of the battery was proved to be great, by its heating the whole of its own helix, and by the brilliancy of the discharge when made through charcoal." The results caused by this experiment proved in Faraday's hands the clue to the electrical labarynth in which he had been wandering so long in comparative darkness; and he rapidly traversed the field of discovery now opening around him. He found by varying the form of the preceding experiment that it was sufficient to exhibit proofs of induction, if he merely moved the inducible in front of the inducing wire, since as the former was made to approach to, or recede from the latter, so the galvanometer was affected, indicating on the approximation of the wires an induced current in a *contrary* direction to the inducing current, while on their recession the two currents had the *same* direction. Efforts were then made to exhibit in it like effects to the preceding, with wires conveying charges of common electricity, but without any satisfactory result, in consequence of the instantaneous discharge of the current rendering it impossible to separate the effects due to its commencement from the equal and contrary effects due to its close. Time enters as a necessary element with the induction of voltaic currents; but in discharges of common electricity, this element cannot be commanded. The peculiar action to which we have now alluded, has been termed by Faraday volta-electric induction.

We formerly, in briefly adverting to the Amperian theory of magnetism, stated that a voltaic current, circulating in a wire of a peculiar form, namely that of a vertical, spiral, or helix, was, to all intents and purposes, a magnet; and hence the step from volta-electric to magneto-electric induction was an immediate and necessary one. As introductory however to the use of the magnet itself, Faraday experimented on the effects of adding an iron core to his helices; and when this was done, it was found that, using the same strength of battery, the influence of the current, as indicated by the galvanometer, was *tenfold* greater than when no iron was present. So powerful indeed was the impetus communicated to the galvanometer needle, that when the battery of one hundred pairs of plates was used, it spun round three or four times before the action of the air, and terrestrial magnetism could reduce its motion to simple oscillation: a minute *spark* was also exhibited by using charcoal terminations to the inducible wire, invariably on making, but rarely on breaking contact at the battery.

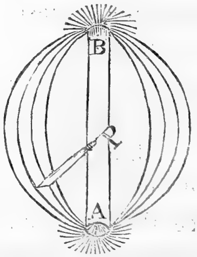
A pair of *common bar magnets* was then substituted for the galvanic battery, and it was then found that by simply making, and breaking magnetic contact, powerful electrical currents were induced in the helices employed. The details of the first experiment by which this discovery was established are so short and simple, that we shall transcribe them here. "A combination of helices, like those above described, was constructed upon a hollow cylinder of pasteboard; there were eight lengths of copper wire, containing altogether 220 feet: all of these helices were connected end to end, and then with the galvanometer, by means of two copper wires, each five feet in length. A soft iron cylinder, seven-eighths of an inch thick, and twelve inches long, was introduced into the pasteboard tube; a couple of bar magnets were arranged with their opposite poles at one end in contact, so as to resemble a horse-shoe magnet, and then contact made between the other poles, and the ends of the iron cylinder, so as to convert it for a time into a magnet. Upon making magnetic contact, the needle was deflected; continuing the contact it became indifferent; on breaking the contact it was again deflected, but in the opposite direction to the first effect; and then it again became indifferent." By other experiments it was proved that the electrical currents induced in the copper helices were due solely to the mere approximation of the inducing magnet, and by employing a very powerful compound magnet, it appeared that the mere motion of a *single copper wire* in front of, but *without making contact* with, the magnet, was sufficient to induce in it currents of electricity. At first no chemical, calorific, nor physiological effects could be produced by the induced electrical current, but on repeating his experiments more at leisure, with a natural magnet or loadstone, capable of lifting thirty pounds, Faraday found that *a frog was powerfully convulsed*, and he thought at the same time he could perceive the *sensation* upon the tongue, and the *flash* before the eyes, although he still failed in producing chemical decomposition. The various experiments however which he made, appears to furnish the fullest warrant for the conclusion that electricity may be produced from common magnetism. "That its intensity," he remarks, "should be very feeble, and its quantity very small, cannot be considered wonderful, when it is remembered that, like thermo-electricity, it is evolved entirely within the substance of metals retaining all their conducting power. But an agent which is conducted along metallic wires in the manner described; which, while so passing, possesses the peculiar magnetic actions and force of an electric current; which can agitate and convulse the limbs of a frog, and which finally can produce a spark by its discharge through charcoal, can only be electricity."

Faraday proceeds, in the third section of his first series, to communicate his views as to the state into which the inducible wire is thrown during the continuance of the inductive action upon it; but as he subsequently abandons the idea of the electro-tonic condition as he calls it, we conceive it unnecessary to take up our time and space in dwelling upon it, and therefore proceed at once to the fourth section, which is occupied by explanations of certain extraordinary magnetic phenomena, discovered by M. Arago, and which had long defied the efforts of the most able philosophers to account for them.

In the year 1824, M. Arago shewed, that if a plate of copper, or indeed of any other substance, be placed immediately under a magnetic needle, it diminishes sensibly the extent of its oscillations, without however affecting their duration; and the needle is brought to rest in a shorter time than if no such substance were placed near it. The converse of this experiment however exhibited much more remarkable results; for if a plate of copper be revolved close to a magnetic needle, so suspended that the latter may rotate in a plane parallel to that of the former, the magnet tends to follow the motion of the plate; or if the magnet be revolved, the plate tends to follow its motion even although both may be of several pounds weight. M. Arago asserts that the phenomena alluded to may be produced with all substances, although this assertion has not been found capable of verification by other experimenters. The subject was investigated in England by Mr. Babbage and Sir John Herschell; but their efforts proved completely unsuccessful, and to Faraday belongs the undivided merit of having removed all that obscurity which, up to the date of his researches, had enveloped it.

Employing the large compound magnet previously alluded to, he found that by rotating between its poles a copper disc, a permanent deflection of the galvanometer needle, to the extent of 45° could be maintained, thus demonstrating the production of a permanent, whereas before he could only obtain a momentary, current of electricity by common magnetism. Motion of the plate was found to be essential to the development of this current, since while it remained at rest, no deflection of the needle occurred; and with reference to the *relation of the current* of electricity produced to the magnetic pole, and to the direction of rotation of the plate Mr. Faraday remarks that "it may be expressed by saying that when the unmarked pole (or that pointing to the south pole of the earth) is beneath the edge of the plate, and the latter revolves horizontally, screw-fashion, the electricity that can be collected at the edge of the plate nearest the pole is positive;" while that collected at the centre and neighbouring parts is negative. The currents in the plate are therefore from the centre by the magnetic pole to the circumference. Hence then it appears that the case of the copper disc is only an extension of that formerly noticed, wherein a single piece of metal had currents of electricity developed in it, at right angles as to the direction of the motion, and crossing it at the place of the magnetic pole, or poles between which it was made to move. For if we conceive this wire to be moved in front of the magnet, like the spoke of a wheel, a current of electricity tends to flow through it from one end to the other; and as a solid disc is made up of an infinite number of such spokes or radii in contact, the currents will tend to flow in the direction of these permanently, if a channel be open for their return, which, in a continuous plate, is afforded by the lateral portions on each side of the particular radius near the magnetic pole. The existence of electrical currents being thus the sole cause of the magnetism of rotation, it is at once apparent why all effects cease when motion ceases, since the currents have then no existence; and it will be found that, on applying the same principle of explanation to the various results obtained by Messrs. Arago, Ampere, Babbage, Herschell, and Harris, the most harmonious and explicit results are obtained.

The rapidity and facility with which Faraday appears to have apprehended the law of magneto-electric induction is very remarkable, and indicates forcibly the clearness of his conceptions of the relations of forces in space; since by common consent of all who have turned their attention to the subject, the law in question is exceedingly difficult to seize at once, from the complicated manner in which electrical and magnetic forces are related, the one set being at right angles to the other. No such difficulty however seems to have impeded Faraday's course; for he remarks, "the relation which holds between the magnetic pole, the moving wire or metal, and the direction of the current evolved, i. e. *the law* which governs the evolution of electricity by magneto-electric induction is very simple, although rather difficult to express. He then represents it by referring position and motion to the curves that pass from one magnetic pole to another, as indicated by the manner in which small iron filings arrange themselves, when strewed upon a sheet of paper placed over a magnet. "The current of electricity," he states, "which is excited in a metal, when moving in the neighbourhood of a magnet, depends for its direction altogether upon the relations of the metal to the resultant of magnetic action, or to the magnetic curves, and may be expressed in a popular way thus: Let A B (see figure) represent a cylinder magnet, A being the marked pole, and B the unmarked pole. Let P N be a silver knife-blade, resting across the magnet with its edge upwards, and with its marked or notched side towards the pole A; then in whatever direction or position this knife be moved, edge-fore-most, either about the marked or the unmarked pole, the current of electricity produced will be from P to N, provided the intersected curves proceeding from A abut upon the notched surface of



the knife, and those from B upon the unnotched side. Or, if the knife be moved with its back foremost, the current will be from N to P in every possible position and direction, provided the intersected curves abut on the same surfaces as before. A little model is easily constructed, by using a cylinder of wood for the magnet, a flat piece for the blade, and a piece of thread, connecting one end of the cylinder with the other, and passing through a hole in the blade, for the magnetic curves; this readily gives the result of any possible direction."

The results detailed in the section on magneto-electric induction were obtained with equal facility by the employment of electro-dynamic cylinders instead of magnets, thus affording additional experimental evidence in favour of Ampere's beautiful and comprehensive theory, and all tending to prove "that the power of inducing electric currents is circumferentially exerted by a magnetic resultant or axis of power just as circumferential magnetism is dependent upon, and is exhibited by, an electric current."

Having discovered the law relative to direction according to which magneto-electric induction took place, it became immediately apparent that the earth itself might be substituted for the magnets employed in all the previous experiments; and accordingly in his second series of Experimental Researches, Faraday investigates the subject of terrestrial magneto-electric induction, and furnishes the most striking instances of the production of electrical current, by the influence of the magnetism of the above. Having taken a hollow copper helix, into which a cylinder of iron, first heated red hot, and then slowly cooled, to deprive it of all magnetism, was inserted; he attached the wires of the helix to those of a galvanometer, and holding the combined bar and helix in the magnetic direction or line of dip, he merely inverted them, so that the lower extremity became the upper, the whole being still in the magnetic direction, and immediately the needle was deflected, so as ultimately to describe arcs of no less than 150° or 160°! This, and other results, led Faraday to hope that the direct inductive effect of the earth's magnetism might be exhibited without the aid of iron, and he accordingly found that by using merely the copper helix above alluded to, and inverting it several times in the line of dip, the galvanometer needle could be made to vibrate through arcs of 80° or 90°. "Here, therefore," he infers, "currents of electricity were produced by the direct inductive power of the earth's magnetism, and without the use of any ferruginous matter, and upon a metal not capable of exhibiting any of the ordinary magnetic phenomena."

Passing now to the subject of the magnetism of rotation, it was found that all the phenomena of the revolving copper plate could be exhibited without the use of any other magnet, than the earth. Upon rotating this plate in a horizontal plane, which in the latitude of London, where the experiments were made, would be inclined about 7° to the line of dip, the needle was immediately deflected, while, in perfect accordance with the law of magneto-electric induction, if this rotation took place in the plane of dip, then no effects were produced upon the galvanometer, since the magnetic curves were not in this case intersected, and without such intersection electrical currents could not be developed. The moment however the inclination of even a few degrees to the plane of dip was given to the plane of the plate's rotation, then electricity made its appearance, and became more and more powerful, till the inclination reached 90°, when for a given velocity it was a maximum. "It is a striking thing," says Faraday, "to observe the revolving copper plate become thus a *new electrical machine;* and curious results arise on comparing it with the common machine. In the one, the plate is the best non-conducting substance that can be applied; in the other, it is the most perfect conductor; in the one insulation is essential; in the other it is fatal. In comparison of the quantities of electricity produced, the metal machine does not at all fall below the glass one, for it can produce a current capable of deflecting the galvanometer needle, whereas the latter cannot. It is quite true that the force of the current thus evolved has not as yet been increased so as to render it available in any of our ordinary applications of this power; but there appears every reasonable expectation that this may hereafter be effected: and probably by several arrangements. Weak as the current may seem to be, it is as strong, if not stronger, than any thermo-electric current: for it can pass fluids, agitate the animal system, and, in the case of an electro-magnet, has produced sparks." From the rotation of a plate transition was made to that of a metallic globe, and as in this the currents are nowhere interrupted, it was natural to anticipate powerful effects. Nor did disappointment ensue, for although the brass ball employed was only four inches in diameter, and turned merely by the hand, the needle became immediately affected, and by varying the form of experiments, the deflections caused were in all cases such as to prove that the needle was influenced solely by electrical currents in the substance of the ball. These results suggested an experiment of extreme simplicity, of which Faraday remarks: "The exclusion of all extraneous circumstances and complexity of arrangement, and the distinct character of the indications afforded, under this single experiment, are an epitome of nearly all the facts of magneto-electric induction." We cannot therefore do better, since its details are very brief, than give it at length. "A piece of common copper wire about eight feet long, one-twentieth of an inch in thickness, had one of its ends fastened to one of the terminations of the galvanometer wire, and the other end to the other termination; thus it formed an endless continuation of the galvanometer wire; it was then roughly adjusted into the shape of a rectangle, or rather of a loop, the upper part of which could be carried to and fro over the galvanometer, whilst the lower part, and the galvanometer attached to it, remained steady. Upon moving this loop over the galvanometer from right to left, the magnetic needle was immediately deflected : upon passing the loop back again, the needle passed in the contrary direction to what it did before ; upon repeating these motions in accordance with the vibrations of the needle, the latter soon swung through 90° or more. The relation of the current of electricity produced in the wire to its motion may be understood by supposing the convolutions of the galvanometer away, and the wire arranged as a rectangle with its lower edge horizontal, and in the plane of the magnetic meridian, and a magnetic needle suspended over and above the middle part of this edge, and directed by the earth. On passing the upper part of the rectangle from west to east, the marked (or north) pole of the needle went west; the electric current was therefore from north to south in the part of the wire passing under the needle, and from south to north in the moving or upper part of the parallelogram. On passing the upper part of the rectangle from east to west, the marked pole of the needle went east, and the current of electricity was therefore the reverse of the former." This experiment proves with what remarkable facility currents of electricity are produced in metals moving under the influence of magnets; and when we reflect upon the universal influence of the magnetism of the earth, the startling inference follows, that scarcely a single piece of metal can be without an electric current existing within it. "It is probable," Faraday adds, "that amongst arrangements of steam-engines and metal machinery, some curious accidental magneto-electric combinations may be found, producing effects that have never been observed, or if noticed, have never as yet been understood : what, for instance, may not be the magneto-electric combinations producing their daily effects unseen, amid the beautiful and complex mechanism of the Calcutta Mint, or during the extensive and varied operations in metals, in constant progress in the Foundry at Cossipore!

A farther consideration of the effects of terrestrial magneto-electricited action, appeared to Faraday to lead irresistibly to the conviction that inductive action must be produced by the earth on its own mass, in consequence of its diurnal rotation, and a curious and interesting series of experiments were undertaken, with the view of verifying this impression. Conceiving it not impossible that certain natural differences might exist between bodies as to the intensity of the current produced in them by terrestrial induction, especially as Messrs. Babbage, Herschell, and Harris had found great differences between metals and other substances, as well as between metals and each other, he inferred these differences might be rendered sensible by opposing the bodies to each other. This view was however not confirmed by experiment, for although he opposed copper to iron, and copper to a large mass of pure still water, being the lake in the gardens of Kensington Palace, he could procure no decisive galvanometrical effects; and it appeared that when cutting the magnetic curves with equal velocity, even such dissimilar bodies as copper and water exactly neutralised each other's effects. He then examined the curious and interesting results obtained by Mr. Fox of Falmouth, relative to the electricity of metalliferous veins, with the view of discovering whether any of these were due to magneto-electric induction, but believes, although not able to speak strongly, that they are not. As increased length of the substance acted upon increases the intensity of the current, Faraday hoped to obtain, with large masses of moving water, sensible effects, although quiescent water gave none. He therefore experimented on the Thames at Waterloo Bridge, by stretching a copper wire nine hundred and sixty feet in length along the parapet of the bridge, and dropping from its extremities other wires, having extensive plates of metal attached to them, to complete contact with the water. With this arrangement constant deflections of the galvanometer were procured, but with great irregularity, and they were in succession referred to other causes than that sought for. The different condition of the water as to purity on the two sides of the river ; the difference in temperature ; slight differences in the plates and in the holder used ; all produced effects in turn, and nothing satisfactory could be observed. Still, however, although in these experiments sensible effects could not be obtained, it is nevertheless theoretically true that, whenever masses of water are flowing, then electrical currents are formed, and hence it may be inferred that the great oceanic currents, the flow of tidal waves, and of the vast rivers of the old and new continents will, by influencing the intensity of terrestrial magnetism, exercise a perceptible effect on the directions of the iso-dynamic lines, or lines of equal variation on the earth's surface in their immediate vicinity. Before leaving this branch of the enquiry, Faraday remarks : "I hardly dare venture, even in the most hypothetical form, to ask whether the Aurora Borealis and Australis may not be the discharge of electricity thus urged towards the poles of the earth, from whence it is endeavouring to return by natural and appointed means above the earth to the equatorial regions. The non-occurrence of it in very high latitudes is not at all against the supposition ; and it is remarkable that Mr. Fox, who observed the deflections of the magnetic needle at Falmouth, by the Aurora Borealis, gives that direction of it, which perfectly agrees with the present view. He states that all the variations at night were towards the east, and this is what would happen, if electric currents were setting from south to north in the earth, under the needle, or from north to south in space above it."

Proceeding to compare the magneto-electric effect produced upon different metals by the magnetism of the earth, it was found to be in direct proportion to their conducting powers, and the order in which the different metals experimented upon is placed, is as follows, copper, zinc, tin iron, and lead. That the electric currents produced are *exactly* proportional to, and dependent upon, the conducting powers, Faraday conceives to be established, by the perfect ventrality displayed when two metals, or other substances, as acid, water, &c. are opposed to each other, for then the feeble current, which tends to be produced in the worse conductor, has its transmission favoured in the better conductor, and the stronger current, tending to form in the latter, has its intensity diminished by the obstruction of the former; and the forces of generation and obstruction are so perfectly balanced as to neutralise each other exactly : therefore as the obstruction is inversely as the conducting powers, the tendency to generate a current must be directly as that power to produce this perfect equilibrium.

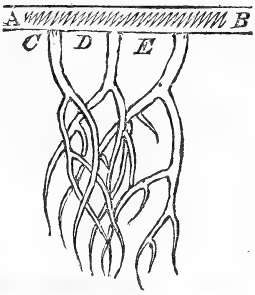
In endeavouring to explain the phenomena of the magnetism of rotation, Messrs. Babbage and Herschell had attributed them to the production, during the period, of rotation in the rotating plate, of a feeble polarity, similar in kind to that existing in iron. When by the adjustment of the attractive and repulsive forces exerted in different positions between the magnet and plate, the singular results it was considered might be explained. This view, as we formerly remarked, proved utterly inadequate to the explanation of the phenomena, save in the single case of iron; and Faraday now thought he had devised a decisive experimental test, by which it would be shewn whether the polarity developed during rotation was of the same, or of an entirely different nature to that present in ferruginous bodies: "no other known power," he reasoned, "has like direction with that exerted between an electric current and a magnetic pole; it is tangential, while all other forces acting at a distance are direct. Hence, if a magnetic pole on one side of a revolving plate, followed its course by reason of its obedience to the tangential force exerted upon it by the very current of electricity, which it has itself caused, a similar pole on the opposite side of the plate would immediately set it free from this force; for the currents which tend to be formed by the action of the two poles are in opposite directions; or rather no current tends to be formed, or no magnetic curves are intersected, and therefore the magnet should remain at rest. On the contrary, if the action of a north magnetic pole were to produce a southness in the nearest part of the copper plate, and a diffuse northness elsewhere, as is really the case with iron; then the use of a north pole on the opposite side of the same part of the plate should double the effect, instead of destroying it, and double the tendency of the first magnet to move with the plate. On submitting these views to the test of experiment, the fullest evidence was obtained that with iron, and other bodies admitting of ordinary magnetic induction, *opposite* poles on opposite sides of the edge of the plate neutralise each other's effect, whilst *similar* poles exalt the action. But with copper and substances not sensible to ordinary magnetic impression, *similar* poles on opposite sides of the plate neutralise each other; *opposite* poles exalt the action, and a single pole at the edge or end does nothing." "Nothing," Faraday concludes, "can more completely shew the thorough independence of the effects obtained with metals by Arago, and those due to ordinary magnet force; and henceforth therefore the application of two poles to various moving substances will, if they appear at all magnetically affected, afford a proof of the nature of that affection. If opposite poles produce a greater effect than one pole, the result will be due to electric current. If similar poles produce more effect than one, then the power is *not* electrical; it is not like that active in the metals and carbon when they are moving, and in most cases will probably be found to be not even magnetical, but the result of irregular causes not anticipated, and consequently not guarded against." It therefore appears that there are in reality very few bodies magnetic in the same manner as iron; and as warranted by the result of his investigations, Faraday divides all substances into three classes with reference to their relation to magnets; first, those which are affected when at rest, like iron, nickel, &c. being such as possess ordinary magnetic properties; then those which are affected when in motion, being conductors of electricity in which currents are produced by the inductive force of the magnet; and, lastly, those which are perfectly indifferent to the magnet, whether at rest or in motion.

Extended research will still be necessary to afford a foundation for a theory including all these differences; but we may remark, that it appears as if iron and its associate bodies were *constantly* in that state into which copper and other conductors are thrown *temporarily*, while by their rotation they are intersecting magnetic curves, and hence, since it is evident that electricity in motion is the source of this state in the latter case, it follows that it must be so likewise in the former: and from the researches on magneto-electric induction of Faraday, the magnetic theory of Ampère receives additional and powerful confirmation.

We have now terminated our notice of the first and second series of the researches, and we would fain hope that in presenting, although it has necessarily been in general terms, a view of their varied and important results, our labour has not been in vain: we have still an extensive field before us in the remaining researches, which increase interest and value as they progress: to these we will return on another occasion, and meanwhile would only in conclusion state, that general law, to which the wonderful assemblage of new phenomena discovered by Faraday has been reduced. This law is, that if a wire cut the magnetic curves, a power is called into action that tends to excite in it an electric current; and if a mass move across the same curves, its parts being in different directions, and with varying angular velocities, there also are electric currents called into existence.

Fictitious Vegetable Impressions in Sandstone Rocks. By Lieut. R. Baird Smith, *Bengal Engineers.*

An observation recently made on the effects produced by very minute currents of water on the surface of newly deposited beds of sand, has led me to conjecture, that possibly some of those vegetable-like impressions so constantly found in sandstone rocks, may owe their origin to the action of similar causes, instead of being the casts of decayed organic structures. The circumstances under which the observation alluded to was made, were these : to facilitate certain repairs to a masonry dam across the Nowgong river, which intersects the line of the Doab canal, about sixteen miles to the northward of Saharanpore, a temporary "bund," or breastwork of sand, protected from the action of the water by means of piles and fascines of straw, was thrown across the river. The water, however, percolating the sand in minute streams, carried with it a considerable quantity of fine sand, very similar in appearance to that, by the aggregation of which, the sandstone of the Siwalik Hills is formed, and deposited it on the masonry flooring of the dam, to the thickness of about an inch at the thickest part. On examining the surface of this deposit, I was much struck by the vegetable-like appearance exhibited by the small channels cut in it by the running streams, since they presented a perfect assemblage of the stems, main, and lateral branches of shrubs. I annex a rough outline of a portion of the surface



of the bed, shewing very distinctly the nature of the effects to which I refer; A B being the breastwork of sand, C, D, E, shewing the regular disposition of the minute channels on the surface of the deposit: these are invariably broadest at the point where they issue from the mass of sand, and gradually diminishing as they progress, divide themselves alternately into a fine network. Since it may with confidence be inferred, that the cause to which these effects are due, would be in frequent and extensive operation during those periods required for the formation of our numerous sandstone rocks, it appears to follow, that it may occasionally be necessary to distinguish between these surface impressions due to the action of very small streams of running water, and those due to actual imbedding of vegetable remains. It will readily be admitted, that could an impression equally regular in its outlines, be transferred to a mass of sandstone, it would be difficult to resist the conviction of its organic origin, and as I have not before seen any reference made to the production of such impressions by the cause herein adverted to, I trust the few observations I have made, as they may tend to eliminate error, will not prove uninteresting. It is easy to conceive a geological catastrophe, which would lead to the immediate enclosing of impressions made by running water in the mass of a sandstone formation; as for example, the covering of a tract of country by volcanic mud or sand, or by the sudden disruption of a lake, the waters of which were heavily charged with sediment or the deposit on the surface of the ground of the sand held in suspension by rivers after heavy floods.*

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* Some sandstones derive a slaty structure from these *arborescent,* or as Professor Jameson calls them, *dendritic delineations,* which, however

Before concluding, I may advert to another peculiarity I have observed in the action of water when falling as rain upon masses of earth exposed to it. This is the division of the surface into a series of regular prismatic columns, occasionally so perfect, as to represent a mimic Giant's Causeway, and shewing a curious analogy between the action of fire and water, the two great antagonist, but co-operative forces in the dynamics of Geology. This prismatic arrangement I have observed only on a very small scale, in different spots in the neighbourhood of Mussoorie, and in some of the sections in the nullah's beds in the plains, and attribute its existence to the varying tenacity of the surface soil, parts of which yielding sooner than others to the action of the rain, afford greater facilities for its erosive power to operate. An impression exists on my mind, that I have seen the same sort of structure, but on a much larger scale in the district around Bangalore, in the Mysore country, but having made no written record of the circumstance, I cannot speak positively. Perhaps, Captain Campbell, whose observations on these localities are as minute and careful in detail, as they are interesting and important in general results, may be able to supply some information on the point to which I have alluded.

have always been regarded as mineral rather than organic characters. The cause of these singular and beautiful characters in rocks is still, however, an unsettled point in which the observations of Lieut. Smith must have considerable influence.—Ed.

Suggestions regarding the probable origin of some kinds of Kunkur, and the influence of deliquescent Salts on Vegetation. By Captain J. CAMPBELL, *Assistant Surveyor General, Madras Establishment.*

The information which Mr. Liston has obligingly given us at page 125 of this volume, refers to some remarks by me published in the India Review, written in consequence of reading the paper by that gentleman, page 236, vol. i. of this work.

In the soils of Mysore and of the Barramahal, I have found that muriate of lime and of magnesia are very common; in some spots in such profusion, that I have obtained two or three ounces of these salts by lixivating about a peck of the earth. Both the above salts are very deliquescent, and therefore such spots are remarkable by being quite damp, while all the surrounding soil was quite dry in the hot weather. The surface of the red marle formation of Mysore is generally bare and arid, but at Burrah Ballapoor, 14 miles S. W. of Nundidroog, the spot is particularly fertile, and the above deliquescent salts are found on lixivating the soil of the hollows.—Similar soils to those which yield the salts in the greatest profusion are scraped up, and applied by the native gardeners to the surface of the soils of brinjal gardens, by which the fruit becomes of very large size, and at Bullapoor, where the salts are common, the brinjals are commonly full five inches in diameter.

Lieutenant Newbold remarks (Madras Journal, vol. x. page 117): " It is a curious fact that many gardens, particularly at Bellary, formerly extremely productive, now yield comparatively speaking, little or nothing; this I have found to arise from the practice of irrigating them with water drawn from brackish springs, the water evaporating leaves its saline contents disseminated in the soil, which by constant progressive accumulation, first diminishes, and afterwards destroys the power of vegetation." As Lieutenant

Newbold does not appear to have examined either the saline contents of either the water or the soil, a latitude for speculation may be assumed, and I am inclined to think it probable that the garden may have owed its fertility to the deliquescent salts in question, and that these being decomposed by the possibly alkaline water of the well, have made the soil unproductive, in consequence of its being deprived of a supply of moisture absorbed from the air; or from no longer being able to retain the moisture supplied to it.

From the facts above stated, I am inclined to think that deliquescent salts in soils may produce considerable effect upon the fertility of land in tropical climates, and as I am not aware that the remark has ever been made before, it may be as well that experiments should be made upon this subject. For this I have myself neither leisure nor opportunity, but to any person who will take up the enquiry, I would suggest, in the first place, to try if muriate of lime produces any deleterious action upon the roots of a plant. This might be easily done by setting a plant growing in a flower pot in a saucer filled with a strong solution of the salt, which has been exposed for several days to the atmosphere, and in the next place, the effect of weak solution should be tried. The muriate of lime for the purpose may be readily made by adding quick lime to a solution of the sal-ammoniac of the bazars, and boiling it until no more ammonia is given off.

Mr. Liston in his remarks at page 236, vol. i. of this work, alludes to a kind of soils which he terms "*banjar*," and mentions that they require to be irrigated. If they are incapable of producing crop without being irrigated, there must be a very remarkable difference between the soils of Bengal and of the South of India, for every kind of soil in this part of the country is productive, except when it is too sandy or too stony. Our soils therefore resemble more what Mr. Liston calls "*bhat*," which possibly derive the power of retaining moisture from the deliquescent salts they may contain. This might be easily proved by lixivating portions of the different soils.

I do not find that we have any information regarding the geology of Goruckpore, but, supposing that most of the soils of Bengal are alluvial, (in South India very few soils are so,) it would seem extraordinary how they should contain a salt.

Many of the wells of the Barramahal contain muriate of lime in considerable quantity, yet it does not appear that the people and cattle who use the water suffer any ill effects from it. I am informed by a medical authority that many wells and springs in South India are known to contain salts which produce bad effects upon the health of persons not accustomed to the use of them.

In consequence of the prevalence of muriate of lime in the soils of South India, it may naturally be supposed that some kinds of Kunkur, such as the branched ramified kind, (which some writers have supposed to be formed by deposition upon the roots of plants,) may have been produced by the decomposition of the muriate of lime by the carbonate of soda, which appears to be common in many parts of India; and accordingly the red marle formation of Mysore, where the carbonate of soda is scarce, so also kunkur is almost unknown, while in the Barramahal, soda and kunkur generally occur together. This would be a famous subject to theorise upon, but I shall pursue it in detail no more at present.

The accounts which Mr. Liston has given us of the action of tests on the waters he had examined, are much the same as upon the waters of the saline wells in the South of India. The precipitate by boiling is most probably sulphate of lime, which being only slightly soluble, the water may have been saturated with it, and a portion was deposited as the water was driven off in vapour. The effects of tests for lime or for muriatic acid are not given, but we must hope that Mr. Liston will not let the subject drop.

The water may be tested first with a little solution of soap in alcohol, which will shew if it contains any earthy salt; that it contains no metallic salt, has been shewn by prussiate of potash producing no effect.

Oxalic acid, phosphoric acid, or their alkaline salts will shew if the water contains any lime, and a little lime water will shew if it contains any free carbonic acid, which might cause the precipitate on boiling. Nitrate of silver will shew the presence of muriatic acid, and an alkalic prosphate with excess of ammonia will shew the presence of magnesia.

Mr. Liston of course will be perfectly aware of what the action of the above tests indicate, but I make the remark to point out which will be most satisfactory if the subject is followed up.

This subject leads me to what may be called "improvising," tests, for want of a better word. Gentlemen travelling with only a small test chest may often provide themselves with tests by a little ingenuity. For instance, as the principal acids will be always at hand, a test for lime may be provided on an emergency by burning a bone, pounding it, pouring a little sulphuric acid on it, adding a little water, letting it stand ten minutes, filtering, supersaturating the solution with ammonia and filtering again; a little phosphate of ammonia containing only a very small portion of sulphate, will be thus provided fit to be used as a test in five minutes. Or a little sugar-candy may be boiled with some nitric acid for five minutes, and the filtered solution saturated with ammonia will be a mixture of oxalate and nitrate of ammonia, which will be a capital test at once. It is unnecessary to pursue the subject farther in this place, but it will easily be seen that a traveller well acquainted with the processes of operative chemistry may very often supply his wants on an emergency with very slender means at command, and may thus render it unnecessary to lumber himself with a multitude of tests.

Remarks on Pteropus Edulis, Geoffroy. By Lieut. Tickell.

Plate. III.

Order, 3d Carnassier—*Family,* Cheiroptera—*Genus,* Vespertilio—*Subgenus,* Pteropus (of Brisson)—*Species,* Edulis? (of Geoffroy.)

"Black Roussette"—Flying Fox—Kalong of Java—Badoor of Hindoostan—Malanon Bourou of the Malays.

Dimensions of a mature Male.

		feet.	*inch.*
From tip to tip of wings,		4	2
Snout to rump,			$11\frac{3}{4}$
Head,			$3\frac{1}{3}$
Humerus,			5
Radius,			$6\frac{1}{2}$
Thumb, (without claw,)			2
Claw of thumb, (chord to arc,)			$\frac{8}{10}$
Little finger,			$8\frac{7}{10}$
Of which 1st Phalanx,	0 $4\frac{7}{10}$		
2d Ph.,	2		
3d Ph.,	2		
Second finger,		0	$10\frac{2}{10}$
1st Phalanx,	0 $4\frac{5}{10}$		
2d Ph.,	$2\frac{9}{10}$		
3d Ph.,	$2\frac{8}{10}$		
Middle finger,		1	1
1st Phalanx,	0 $4\frac{6}{10}$		
2d Ph.,	$3\frac{5}{10}$		
3d Ph.,	$4\frac{9}{10}$		
Index finger,		0	5 (with little claw.)
1st Phalanx,	3 $\frac{4}{10}$		
2d Ph.,	$\frac{9}{10}$		
3d Ph.,	$\frac{7}{10}$		

	feet.	*inch.*
Femur, ...	0	2
Tibia, ...		$3\frac{2}{10}$
Hind paw, ...		2
Its claw (cord to arc), . .		$\frac{8}{10}$
Length of ear, ...		$1\frac{6}{10}$
Between ears, ...		$1\frac{8}{10}$
Between shoulders across back, ...		$2\frac{1}{2}$
Breadth of interfemoral membrane, ...		$1\frac{1}{2}$

$$\text{Teeth, } \begin{array}{ccccc} \textit{incisors.} & & \textit{canines.} & & \textit{molars.} \\ 4 & — & 1.1 & — & 4.4 \\ \hline 4 & — & 1.1 & — & 6.6 \end{array} \text{ or } \begin{array}{ccccccc} \textit{inc.} & & \textit{can.} & & \textit{false molars.} & & \textit{mol.} \\ 4 & — & 1.1 & — & 0.0 & — & 4.4 \\ \hline 4 & — & 1.1 & — & 1.1 & — & 5.5 \end{array}$$

Incisors, square, blunt, separate. *Canines* large, quadrangular (being flattened on all four sides), the lower canines flat posteally, anteriorly round. *Upper Molars,* trenchant, conical, triangular, longitudinally bifid, *two next* flat, oblong, longitudinally bifid, *i. e.* a groove runs along upper surface, dividing each tooth into two blunt tubercles. *Last Molar* flat, rudimentary. Behind lower canine, a small rudimentary flat tooth. Next to which molar long, conical. Four next oblong flattened. Last one small. All of them furrowed by a longitudinal hollow into two blunt lateral tubercles.* All the teeth are separate, and when the jaws are closed partially interlock.

Tongue.—Long, narrow, with supplementary tip; thick strong papillæ on upper surface.

Nose.—Septum deeply bifid, broad; nostrils semi-circular; muzzle almost bare, leathery, with small vibrissæ.

Ear.—Conical, sharp-pointed, plain, no developed tragus ; transverse lamina.

Eye.—Pupil round, contracted to a point in day-light.

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* These tubercles become obsolete by age, and the surface of molars flattens.

Colour.—Male. Muzzle almost smooth, black or sooty, which colour extends half way up head, and along the cheeks, but with a browner tinge on latter; fur of chin black, fading through smoky red brown into colour of throat and breast. Head, to as far as line between ears reddish tawny, with smoky red hairs intermixed. Round roots of ears smoky chesnut; from thence to shoulders and top of back clear golden tawny, parted from black of back by an edging of chesnut. *Below* the cheeks, breast, and belly tawny, reddest on throat and chest, pale in centre of belly, and fading into smoky brown about pubis and on flanks. All the limbs covered with smoky black fur. Back and along humerus, plain black with grey hairs mixed, thighs the same. Flying membrane pale, plain blackish inside, ears black, claws ditto: eyes smoky reddish chesnut: nose black: fur near humerus below wings smoky reddish. Genitals black leather.

The female is smaller and obscurer in colour. Head smoky brown, blackish on muzzle. Dark smoky chesnut on throat—under parts dark brownish tawny. Pubis and inside thighs smoky reddish brown. Upper part of back and neck duller than male, and back of thighs dashed dusky red. Cætera pares.

Fur.—Rough below like mohair, lying flatter and smoother on back, but harsh.

Wing.—Humerus and radius very muscular, phalanges of fingers similar to those of other bats, but index ended by a small hooked nail bending upwards, or outwards from the plane of wing. Wing near arm clothed with scanty woolly fur. And from radius to edge of the membrane extend interrupted parallel muscular strips, fifteen in number : these are crossed here and there by veins, and one very large strip runs along interfemoral membrane, up its centre. Cartilaginous appendage from near root of inner toe running through (across) interfemoral membrane, weak and small. No vestige of tail. The wing membrane attaches to the root of the index finger of the hind paw, spreading across front of foot or instep.

Paws.—As in all bats—claws subequal.

Genitals.—Male. Testes large, oval, placed on each side of penis. Penis pendant, with flat denuded glans, having a lateral opening to urethra, becomes erect as in monkey or man.—Female.

Oval, lateral, plain orifice immediately between the bones of the pelvis, which approximate. In both sexes the parts are placed so forward, that it is probable they copulate face to face. Urethra, or womb of female, furcates into two branches, with an ovarium at either extremity.

Mammæ.—Two, pectoral, very far back, remote, immediately under axillæ, very large in female.

Sternum keel-shaped as in birds, for attachment of the strong pectoral muscles. Liver large, deeply divided into four lobes. Intestines very much as in human subject, but apparently no colon or cœcum. Spleen large and long, ribs 12, clavicles distinct. Condyles of jaw transverse oblong preventing lateral motion. Nasal bones prolonged to end of muzzle, so as to *leave but a trifling* quantity of cartilage.

Habitat.—Throughout Continental India, but not beyond the Cis-Himalayan range (I believe). In Java, Sumatra, Malacca, and most probably throughout the Eastern Archipelago and Southern China. Frequents large trees in groves, open country or forest, but always near cultivation.

Remarks.—The "Flying fox" is one of the commonest animals of India, and one of the most characteristic features of a tropical night. Every evening these animals may be seen flying heavily along in one particular direction, singly or in parties of 5 or 6. As they seldom alight until the dusk has deepened, their manners and method of procuring their food on the trees they frequent is seldom noticed, at least by the casual observer, however familiar their demon-like forms may be to him, as they flag heavily through the night air.

The Pteropi rest during day-light on some large tree, preferring for this purpose the tamarind, which they never quit when once selected, although equally inviting trees may be in the immediate vicinity. Generation after generation resort to this one tree, until excess of numbers forces a part to select another, but the transfer is not effected without difficulty, the oldest bats ejecting the weaker and younger. It must have been a familiar sight to many, to see some huge tree, in the centre of a village, on the skirts of a forest or in the midst of a wide plain, garnished by hundreds of the dangling bodies of these animals. A person stationed near such a spot at the first break of dawn might see the Pteropi come stealing back to their retreat from all quarters. From the arrival of the first comer, until the sun is high above the horizon, a scene of incessant wrangling and contention is enacted amongst them, as each endeavours to secure a higher and better place, or to eject a neighbour from too close vicinage. In these struggles the bats hook themselves along the branches, scrambling about "hand over hand" with some speed, biting each other severely, striking out with the long claw of the thumb, and shrieking and cackling without intermission. Each new arrival is compelled to fly several times round the tree, being threatened from all points, and when he eventually hooks on, has to go through a series of combats, and be probably ejected two or three times before he makes good his 'tenure'. The "alarums—excursions," continue till 8, 9, or 10 A. M. when they get sleepy, and hang side by side in peace, fanning themselves with their wings, which in repose they wrap round the head, slumbering with the chin on the breast and the muzzle covered by the membrane of the last phalanges. The usual noises of a village, in the centre of which they often select their roosting place, do not appear to disturb them, or to cause further stir than a production of two or three heads from within their mantles, which after a look on the houses and people below, and a few rapid tremulous movements of the ears, are again popped into their envelopes. The report of a gun causes dreadful commotion; they rise in clouds from the tree, and continue circling round and round, having to fight their battles over again when left to resettle, and to go through the whole scene, shrieking, cackling, and contention of the morning.

Their departure for their nightly rambles is unattended by any of this uproar. As the sun sinks below the horizon, the Pteropi drop silently from the branches, one by one, and sail away into the coming gloom. They first shape their course to a tank or river, and sweeping down to the water's surface, lap as they fly along, until their thirst is sated, when they wend their course to the trees, the fruit of which may happen to be in season.

This animal is entirely frugiverous, devouring almost any fruit, either wild or of the garden, in which at times he makes great havoc, especially among plantains. Among wild fruits, they prefer the mowhooa berries, and the figs of the bar, peepul, and goolar.

They eat, when alighted, in silence, hanging heel downwards by one hind foot, the other being employed in holding the food,* which is devoured slowly, in large mouthfulls at a time, both cheeks being crammed full, and the tongue protruded. Its jaws being incapable of lateral motion, the animal is compelled to open and shut them solemnly up and down, munching, so to say, all the while with great deliberation. Those I have now in captivity (five in number) are fed on goolars, (Ficus glomerata), which they chew in the manner above mentioned, until they have extracted all the juice, when the remaining pulp is ejected out of the mouth. Glutinous and farinaceous food, such as plantains, they do not serve in this manner.

Many classes of Hindoos, especially in Bengal eat these animals, and in Java (if our subject be the same as the "Kalong" of Dr. Horsfield,) they are thought a delicacy. The flesh looks well enough, but the animal has a strong penetrating odour, which one would suppose would affect the taste; this smell is as bad in the female as in the male; it pervades the body, and does not exude from any secreting gland—at least, I can find none.

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* It does not hold the fruit by grasping, but by sticking its claws in, in the fashion of a prong or fork.

The Flying Fox, or "Badoor" is very easily tamed. It will eat or drink from the hand a day or two after capture, even when wounded. It drinks eagerly at all hours, lapping milk or water with its long pointed tongue, and it readily learns to eat in the day time as well as at night. I have kept one now, the wing of which was broken by shot, many weeks. 'Hookey,' as he has been named, has become perfectly familiar, rather fearless than tame, for he attacks the approaching hand, tooth and nail, (literally,) although he will eat and drink from it. He is accommodated with a high narrow box, having a projecting grating, to which he hangs suspended, endeavouring to grapple all passers with sound hook or thumb claw, to see whether they have any eatables upon them. When angry, he opens the mouth, growling or cackling in the fashion of a monkey, and striking out forcibly with the afore-mentioned claw or hook. If the contest wax too warm for him, he swings round, and strides back into his box, head downwards all the time, of course.

The modus copulandi must be, I imagine, *vis-a-vis.* The female generally brings forth one young one, which adheres firmly to the breast by means of its claws, retaining its position whether the dam be flying or at rest. They may bring forth two, but I have seen several old females flying about with a single young one sticking on to them, never with more. The young are born about the end of March and April; they are I believe blind when exuded, and they continue a 'fixture' on the mother till the end of May or early in June, when they are nearly as big as herself.

I should be glad to know whether the present subject is the Pteropus Edulis or Javanicus of Dr. Horsfield. Geoffroy's Cuvier merely describes the animal as black, with top of neck and back tawny. No mention is made of the whole of the under-parts being tawny or brown. The expanse of wings is also given as above 5 feet. The specimen I have here described was the largest of 8 or 9, and not above 4 feet 2 inches across the wings. It is an old one too, for the teeth are well mumbled or worn down.

Seeing that bats are condemned to hang ever head downwards, it is not an impertinent question to ask how they void their excrement, without interfering with their own persons. This is minutely explained in Geoffroy's Cuvier, Mammalia, vol. ii. page 95. The Pteropus goes through the same ceremonies precisely as the bats described in that publication; viz. when urged by the call of nature, it adroitly reverses its position by hanging on with the thumb claws and letting go its feet, when of course, with reference to its own head there is no further occasion for the precaution.

Since commencing this paper, of five I had in captivity, and from which most of these remarks are taken, but one remains, two died of their wounds; one of decline, (although it ate ravenously to the hour of its death;) one flew away. The remaining one is in good condition and perfectly tame. They were very quarrelsome when together, and frequently bit and wounded each other severely. The animals are cruelly infested by a tough nimble spider-shaped tick (Oribata Vespertilionum,) which the most incessant scratching fails in getting rid of.

Methods of estimating accurately the Substances usually present in Water. By Mr. A. Robertson, *Calcutta.*

Before describing these processes, it may be of service to mention something about the vessels to be used, and the manipulation. The quantity of water ought to be determined by weight, as being much more accurate than measurement, and 10,000 grs. is a very convenient portion for the purpose. To concentrate this by evaporation, a wedgewood-ware basin, usually recommended, is rather improper, on account of the difficulty of excluding dust from it, and the porosity of the ware now generally sold under that name. A glass flask is preferable, and much more convenient, the water in it being made to boil briskly on a sand-bath, or over a lamp or chauffer of charcoal. A Florence oil flask is better than a flint glass one, being of a harder glass, less easily attacked by the boiling water, and though it can be filled little more than half full at the outset, as the water is boiled off, it may be filled up by pouring in the remainder of the water through a funnel so as not to touch the empty part of the flask, and doing this smartly before the issuing steam has time to heat the neck of the funnel. In this case there is no risk of breakage.

Should it be required to evaporate to complete dryness, this is best done by using the flask until about 300 grs. of liquid only (unless the water be very saline) remain. This is poured out into a platina vessel, a capsule of German porcelain, or the lower part of a flask cut off, washing out any sediment from the flask by distilled water, and adding it to this fluid remainder. From such a vessel it can be easily removed after all the moisture is dissipated.

In precipitating the different substances, wine glasses do not answer, as the matter thrown down adheres to their conical sides. Test tubes for small portions, and tall vials with flat bottoms for larger, answer much better. It is also much more accurate for small quantities to dispense with filters in collecting precipitates, provided the experimenter be not pressed in point of time. To manage without these, the precipitate should be allowed to subside completely, the clear liquid above it be run off by a small syphon, distilled water put in its place, agitated, allowed to become clear, again run off; and this be repeated till the washing from soluble saline matter be judged complete. The sediment is then transferred into a small procelain capsule or platina crucible, carefully washing the last portions out of the glass, allowed to repose a sufficient time, the clear liquid above removed by a pipette, the moisture evaporated, the precipitate heated to faint redness and weighed, deducting the tare of the little vessel containing it.

Should a speedy result be desired, filtering may be employed, washing the precipitate on the filter with distilled water by a pipette. The thick spongy paper with a rough surface, usually sold as filtering paper, is unsuitable for this, because a very appreciable quantity of the fine precipitate either adheres to its surface inseparably, or even sinks into its substance. The best is a sort of thinish blotting paper, with one of its surfaces apparently glazed, from which the dried precipitate easily scales off, leaving but a very small trace upon it. Weighing the precipitate, on a previously weighed filter, is inadmissible, as the paper will vary in weight according to its degree of exsiccation, and it is scarcely possible to hit the precise stage of dryness in which it was when first weighed. Burning the filter and adding the ashes to the precipitate will give an excess of weight, unless a corresponding portion of the paper be burnt, and the weight of its ashes subtracted. Even in this case, there is a source of error in the obstinate retention, in spite of all washing, of some saline matter in the very edge of the filter, a source of error which also holds in regard to the estimation of substances upon a filter previously weighed.

All precipitates to be weighed should, immediately previous, be exposed to a heat visibly red, with the exception of such as would be volatilized or decomposed by it. These are usually dried, for an hour or two, at the heat of boiling water. The ignition of small quantities is best performed on platina over a spirit lamp.

The first step in the process is to ascertain the substances present in the water, by testing. All natural waters contain a little atmospheric air, sometimes with an excess, sometimes with a deficiency of oxygen. Unless the analysis be a scientific one, this may be neglected. Carbonic acid gas is a usual ingredient. This is most certainly detected, when free, by boiling the water in a retort or flask fitted with a bent tube, and receiving the evolved gas in lime or barytes water, when white carbonate of these earths will be precipitated. Some of the usual methods of preventing error from the absorption of the carbonic acid gas in the atmosphere should be adopted. Carbonates are precipitated by boiling, and recognised by effervescing with acids. Sulphuretted hydrogen is known by its smell, or when in minute quantity, by the blackening of the recent water by salts of lead, bismuth, or copper. It is soon decomposed on exposure to the air. Sulphuric acid is indicated when a white precipitate falls on adding to the water first nitric acid to prevent the precipitation of a carbonate, and then nitrate of barytes. The liquid separated from this precipitate will shew muriatic acid on adding nitrate of silver. Nitric acid, which may be looked for in all surface water in India, is indicated by concentrating the water by evaporation, and adding gold leaf, muriatic acid, and boiling it, or better, by adding a little pure sulphuric acid, free in particular from nitric oxide gas, which almost all ordinary sulphuric acid contains, and putting into it a small crystal or two of pure green proto-sulphate of iron, and applying heat, upon which, if that acid be present, a dark greenish hue will soon pervade the liquid in the neighbourhood of the crystal. Vegetable acids or other matters, such as crenic acid in springs, and vegetable infusory matters in surface waters, will blacken on exposing to heat the residuum of the evaporation of the water; and if animal matter be also present, ammonia will be evolved, shewn by the cloud formed beside a rod dipped in muriatic acid and held over it, or more delicately, by reddening the yellow of moist turmeric paper also held above it. Some of these substances when in solution also give a brown precipitate with nitrate of silver.

The residuum of evaporation, if boracic acid, met with in some waters, be in it, when mixed with a little sulphuric acid will tinge burning alcohol of a beautiful green, not the bluish green given in the fire by common salt. Iodine, though in minute quantity, will, on making thin solution of starch with the water nearly boiling, and *cooling* it, give with a little chlorine water, or even with nitric acid, a blue film where the two different liquids touch each other. Bromine, to be looked for in salt waters, is best detected by heating in a test tube with pure sulphuric acid the precipitate from the water by nitrate of silver, when reddish or yellowish-brown vapours of bromine, like those of nitrous acid, will be evolved.

The bases of the salts usually present in water may be detected as follows:—Lime by oxalate of ammonia, a white precipitate in a somewhat diluted solution. Magnesia, in the water from which the lime has been thus separated, by a white precipitate on the addition of carbonate of ammonia and phosphate of soda or ammonia. Alumina, provided no peroxide of iron be present, by acidulating the water, and adding carbonate of ammonia with constant stirring, so that the liquid may be strongly charged with free carbonic acid, on which there is a white precipitate soluble in potass water, and this, if the quantity of iron be not great, may even be a good test if the iron be previously partially de-oxidized by a stream of sulphuretted hydrogen gas. In general, however, alumina and iron in a solution fall together. Iron gives an ultimately rusty precipitate with an alkaline carbonate, a black with tannin, and if peroxidized, a blood red colour with sulpho-cyanate of potass. Ferro-cyanate of potass is not a good test, as it often gives a blue with an acid solution, owing to a partial decomposition of its own acid. Potass, in a concentrated solution of the water, gives a bright yellow crystalline precipitate with chloride of platina, but no ammoniacal salts must be present, as these yield one exactly similar. Soda is recognised when a little of the residuum of the evaporation is exposed to the blow-pipe flame on a loop of platina wire, by an orange-coloured bright cone of flame proceeding from it. A great excess of potass imparts to this a violet tinge.

If it be desired to ascertain the quantities of the different compound salts contained in any water, the analytical chemist must determine those of their acids and bases, and then by calculation according to equivalents, and the best lights afforded by some chemical facts known regarding the play of elective affinities in such mixtures, proceed to state the compositions in which they exist. Here, though in regard to the most common substances, he has some pretty sure guides, a good deal must be mere probability. One chemist, for instance, supposes that they are in a state of mutual combination, forming only one chemical body, not a mixture of different compounds, but this appears rather unlikely. Another thinks, that they exist in the state of such salts as have the greatest affinity for water, *i. e.* are most soluble, not according to what others imagine, that the strongest acids are united with the strongest bases. This last seems to be a pretty general and probable opinion, but there are a good many facts tending to subvert it.

So far as is known, when a weak compound saline solution is concentrated by evaporation a play of affinities takes place, by which, at the new degree of concentration, old substances are decomposed and new combinations formed. Thus, in evaporating sea water, muriate of lime and sulphate of soda, seem to give sulphate of lime and chloride of sodium; and thus also a solution of bi-carbonate of magnesia and sulphate of lime yields carbonate of lime and sulphate of magnesia. These changes seem to be determined by the relative solubilities of these salts in a certain proportion of the liquid. In like manner, alcohol may often precipitate from a mixture of acids and bases, not the existing compounds, but such new compounds as are insoluble in it. Temperature too has a great effect; for instance, sulphuric and muriatic acids, soda and magnesia, at the freezing point of water, give rise to muriate of magnesia and sulphate of soda, which crystallizes; but at the boiling point, to chloride of sodium, which crystallizes, and a solution of sulphate of magnesia. It is evident then that the complicated methods of separating the different salts in waters, copied by many chemical system writers downwards from the time of their contriver Mr. Kirwan, are, to say the least, useless; even if the practicability and correctness of many of them were not more than questionable.

In proceeding with the analysis after the substances contained in the water have been discovered by testing, the gaseous substances may be first estimated. For the atmospheric air, if it be thought necessary to measure it, take a small tubulated retort, cork the end of the neck, fill it completely with a known quantity of the water, and then stop the tubuture with a cork pierced with a small tube to conduct away the water displaced by the evolved gas. This will be collected in the neck on heating the water to the boiling point. Transfer it into a measure tube. Absorb any carbonic acid by lime or potass, then remove the oxygen by phosphorus. Thus the bulk of the oxygen and nitrogen emitted by a given weight of water, may be readily known.

The free carbonic acid is usually directed to be ascertained by expelling it from the water by boiling, and collecting it over mercury. This, however, gives no good or uniform result in many instances, owing to the long boiling required, and the quantity of water vaporised, before the whole of the excess of carbonic acid is driven off from the bi-carbonates present in the solution. A better process seems to be the following. Pour 10,000 grains of the water into a stoppered flask, add to it an excess of lime water, allow the precipitate to subside, pour off by a syphon the liquid above, wash. The result is a mixture of carbonates with magnesia, alumina, and iron, if present. For strict accuracy, this must be wrapt up in thin paper in one or more pellets, and transmitted to the top of a measure tube full of mercury, where it is decomposed by a little muriatic acid, and the gas given out measured. This is the whole of the carbonic acid contained in the water, whether free or combined. The quantity of the combined is afterwards ascertained in a different manner, and being subtracted from this, the remainder is that which was free. Should lime alone be in the water, the carbonate of lime precipitated may be heated and weighed at once as carbonate, and from it the equivalent of carbonic acid derived. This process is correct only when the carbonic acid in the atmosphere is excluded from the free lime in the flask.

The sulphuretted hydrogen is known by adding solution of muriate of copper in excess, filtering the precipitate from the liquid, and washing it quickly, that it may not be oxidized by the air into sulphate of copper; then putting it moist into nitro-muriatic acid, and boiling till both the copper and sulphur present are dissolved. Muriate or nitrate of barytes will after this give a precipitate of sulphate of barytes, from which the quantity of sulphuretted hydrogen may be easily inferred.

Ten thousand grains of the water should now be evaporated to dryness, the residue heated to slight redness, and weighed to give the whole saline contents of the water, as a check upon the amount of the substances found individually. Thus also the silica, often present, is separated. It will appear like bits of jelly towards the end of the evaporation, and on moistening the dry mass with muriatic acid, allowing it to stand for some time, and then boiling it in water, the silica will remain insoluble. The solution separated from this might serve subsequently for ascertaining the quantity of bases, but as there is always a little loss in each operation, it is better, if there is plenty of the water, to take a fresh portion. Some guess of the quantity of animal or vegetable matters in the water may also be now formed from that of the carbon which will probably be mixed with the silica, and which will be burnt away in igniting it. To determine these exactly, would require difficult and complicated processes, which are not pretended to be here given.

To discover the amount of combined carbonic acid, the greater part of a portion of the water is boiled off; the earthy carbonates and iron are thus precipitated. This precipitate is treated as above, over mercury in a tube, to give the carbonic acid combined with the earths or oxide of iron; or, should it be unmixed carbonate of lime, it may be ignited, and the carbonic acid estimated directly from its weight.

Should the water contain carbonic acid in union with potass or soda, it may be then separated by pouring in solution of pure nitrate of lime. The precipitate is carbonate of lime, from which the carbonic acid may be easily calculated.

To the solution now freed from carbonates, nitrate of barytes is added. From the weight of the precipitate is got that of the sulphuric acid. Should boracic acid be present, the precipitate will contain borate of barytes, which, previous to weighing it, must be dissolved out by digestion in diluted nitric acid.

Into the solution thus freed from sulphates, nitrate of silver is poured to separate the muriatic acid. Chloride of silver precipitates, which must be fused into a horn-like substance, before it is weighed to estimate the chlorine in it. As, in case of boracic acid in the water, it may be contaminated with borate of silver, it must also be previously purified by the action of diluted nitric acid.

The only good method of separating nitric acid is the following: Concentrate the water highly by evaporation. Remove the muriatic acid in it by the action of sulphate of silver. Then add to it in a small retort pure sulphuric acid. Distil to dryness into a receiver in which is water containing pure carbonate of barytes diffused in it. Nitrate of barytes is formed, sulphuric acid is added to this in solution, and from the weight of the precipitated sulphate of barytes, the equivalent weight of the nitric acid is inferred.

The boracic acid may be obtained by evaporation of the water to dryness, adding sulphuric acid in quantity sufficient to decompose the saline matter present, dissolving out the boracic acid by alcohol, adding ammonia to prevent any of it from passing off with the alcoholic vapours, evaporating to dryness and ignition, by which pure boracic acid alone remains.

The bromine will be found associated with the chlorine precipitated by silver, to ascertain the muriatic acid. The quantity of it will most likely be imponderable, and there is no method known by which its separation from the chlorine can be well effected.

Iodine, if present in appreciable quantity, may be precipitated as protiodide of copper by adding a solution of 1 part of sulphate of copper, mixed with 2½ parts of proto-sulphate of iron.

To estimate the bases of the salts contained in the water, a portion of it is concentrated by evaporation, a little nitric acid having been previously added with the double view of retaining in solution the earthy carbonates, and of peroxidizing the iron. Should its saline contents be great, it must not, however, be much concentrated. It is now rendered acidulous by muriatic acid in proportion to the quantity of lime and magnesia it is supposed to contain, and an excess of carbonate of ammonia added with constant stirring. The free carbonic acid evolved keeps in solution the lime and magnesia, provided the solution be not too concentrated, while the alumina and peroxide of iron are precipitated and allowed to subside in a closed vial or flask. Or, instead of this, muriate of ammonia is added to retain in solution the magnesia, then aqua ammoniæ in a flask or vial which the liquid completely fills, and which is closed to prevent the absorption of carbonic acid from the atmosphere. The alumina and peroxide of iron will thus be separated and subside, while the lime and magnesia are retained. In an open glass carbonate of lime would also precipitate.

These mixed precipitates may be separated by boiling them in solution of potass, which dissolves the alumina, and leaves the peroxide of iron. From the potass solution the alumina may be precipitated by adding muriate of ammonia, and boiling it for some time.

The liquid from which the precipitate has been removed is neutralised exactly with muriatic acid, and considerably concentrated by boiling. Oxalate of ammonia will now throw down all the lime as oxalate. This is mixed with sulphuric acid and heated to redness, and from the resulting sulphate of lime the quantity of lime is deduced.

A mixture of carbonate and phosphate of ammonia is now added to the residual fluid. After 24 hours' repose, a precipitation of minute crystalline grains, containing the whole of the magnesia, will be complete. After these have been heated to redness, neutral phosphate of magnesia remains, from which is known the quantity of magnesiat.

Any sulphuric acid in the remaining fluid, together with the excess of phosphoric, is now removed by acetate of lead, and, after this precipitate is separated, the excess of lead is thrown down by carbonate of ammonia. There is now left in solution only chlorides of potassium and sodium, and easily volatilizable salts of ammonia. This solution is evaporated to dryness, ignited, and these chlorides weighed.

They are re-dissolved, and any charcoal from organic matters is separated, and its weight deducted from theirs. A solution of chloride of platinum is added, the whole is evaporated to dryness, and as much is re-dissolved as will dissolve in a little cold water; chloride of potassium and platinum remains, from which is gained a knowledge of the quantity of potass. The quantity of chloride of potassium in it is also calculated, and this, deducted from that of the mixed chlorides, gives that of the chloride of sodium; hence that of the soda is derived. If it be wished to exhibit the chloride of sodium apart, it may be done by separating the excess of platinum in the last solution by carbonate of ammonia, evaporation to dryness, and ignition.

The chemical examination of waters is of immense consequence, not so much in reference to what are properly called mineral springs, as in regard to that water employed in the ordinary purposes of life. The presence of a little animal or vegetable matter, of nitrates, or of a minute portion of some other ingredient, may, by the continued use of such water for months or years, give rise to diseases in a great measure constituting the difference between a healthy and unhealthy locality. It is also of great consequence in the arts and manufactures, such as brewing, distilling, sugar refining, bleaching, and particularly in dyeing. A celebrated dyer of a beautiful red in France, could not succeed on removing his residence to another place. He investigated the cause, it lay in the water, and, on imitating artificially the water at his former residence, his colour became as bright as before.

Chemistry is certainly one of the sciences conducing most to the prosperity of a manufacturing and mercantile nation. What was the iron and coal trade of Britain a century ago, before chemistry taught the proper processes for procuring that iron economically, and rendering it of good quality. What was her cotton manufacture till Watt developed some of the chemical properties of steam, and so set her cotton mills in motion. How limited were her resources in dyeing and calico printing till of late years. To what does she owe the economical artificial light of gas, and her now beautiful porcelain. Seventy years ago, what was the beginning of her sulphuric acid manufactories, which are now estimated to produce for her beneficial consumption eighty thousand tons a year. Thirty years ago, where was the immense production of soda from sea-salt, through which the price of that article, so necessary in many manufactures, has been lowered to at most a fourth of its then cost. What an immense benefit has resulted to sugar refining from the application to it of late of a single chemical principle; and how much has not a rationally applied chemistry done in increasing the fertility of the soil, and the agricultural produce of Great Britain. Chemistry also lends great aid in developing the vegetable, as well as the mineral treasures of a country. It can turn to valuable purposes vegetable substances of once unknown properties; and linked with geology, the offspring of it, a science, which, though now advancing rapidly to maturity, had a few years ago no existence. It can traverse a land, and say, here you will find nothing, because in such a configuration of deposit nothing has yet been found; but here you are likely to find coal, here limestone, here ores of iron, copper, tin or lead, silver or gold, because in such situations these have been hitherto found; and it can determine the composition of these bodies, ascertain their value, and the best means of turning them to account. Such is the rapid progress, that all these wonders have been effected within the memory of many still alive.

Chemistry is one of the most fascinating, as well as one of the most useful of the sciences. Its brilliant experiments, well arranged and dextrously conducted, produce effects far surpassing those recorded in tales of eastern magic, are often indelibly impressed on the youthful mind, and excite a curiosity to know their causes, and an ardour in the pursuit of the science, which no privations can damp, no obstacles repress.

On the Tin of the Province of Mergui. By Capt. G. B. TREMENHEERE, *Executive Engineer. With a Map, Pl.* ii.

(Communicated by the Coal and Mineral Committee.)

1. The tin of this province has not been sought for since the Burmese took possession of the country from their Siamese neighbours. Under the rule of the latter, or during the period at which Tenasserim was an independent state, extensive works for tin were carried on. It occurs chiefly in the beds and banks of streams issuing from the primitive mountains, which form the principal feature of this peninsula. Portions of the banks of streams in which it is found are, in some instances, rivetted with rough stone work to confine the water for washing operations; and the ground on either side for many miles along their course is penetrated by innumerable pits, from eight to ten and twelve feet deep. Traces of the work of many thousands of men are evident in several places. These pits are not connected with one another, but seem to have been sunk by separate small parties of men, to whom probably definite tasks were assigned, with a view of tracing the tin ground, and of extracting the gravel with which the tin is mixed.

Their variable depth, and the amount of labour expended on them, is a tolerable indication of the success with which this has been pursued, and of the places in which ground might be again perhaps opened with advantage.

2. The streams themselves are rich in tin, which may be collected from their beds in considerable quantities. The process by which it has been deposited for long periods, and for many miles along the line of valleys through which they flow, appears to be in active operation at the present day. Crystals of the peroxide of tin washed down by the rivers and deposited with sand and gravel in their beds may, by changes of the river's course during the freshes, be quickly covered with a few feet of gravel and soil. The older deposits have, as far as my observation extends at present, the same alluvial character, and it would be well in future operations to have regard to the levels in which the streams may have formerly run. The first of these localities which attracted my attention was the Thongdan river, issuing from the primitive mountains in the immediate neighbourhood of the coal mine on the Great Tenasserim river. I visited this river in the course of my survey of the coal basin, and found pits in great number along its banks, of the existence of which I had been previously informed, though the object for which they had been dug was not known to my informant. On washing some of the gravel from the bottom of one of the pits, a small quantity of tin was found.

3. A Shan was subsequently sent there, and collected 11,889 grains of tin, of the native peroxide, in the course of an hour and half, Specimen No. 1, which is equivalent to 19 ounces and 198 grains of pure tin.

4. After leaving the vicinity of the coal mine, I proceeded down the river, and was accompanied by the Shan, who had been employed in tin works in the Straits, and to whom several tin streams in the Mergui province were known. These are situated chiefly on the Little Tenasserim river, into which they empty themselves. The first and most accessible is the Thabawlick, which unites with the Thakiet, four miles above the junction of the latter with the Little Tenasserim. The mouth of the Thakiet is eleven miles from the town of Tenasserim.

5. The access to this tin ground is by land in the dry season. Landing at the village of Thakiet, I proceeded on foot eight miles, and reached the Thabawlick at the point indicated in the accompanying sketch.

6. The intervening ground is for the most part flat. After

passing a marsh of some extent, there is a low ridge of hills, which presents, however, no obstacle to land carriage of any description. The face of the country is as usual, except in marshy places, thickly covered with jungle trees, but the wild elephant's track is open and convenient. During the monsoon, boats carrying 100 bags of rice can ascend the Thabawlick to the place alluded to, in one day. The tide is felt about six miles from its mouth.

7. Having arrived at the spot at a point known to my guide, and at which he had the previous year stationed himself for a few months for the purpose of collecting tin, I found numerous pits and old cuttings from which tin had been formerly obtained; it is found in layers of gravel immediately beneath the soil. The surface is undulating, and during the wet season, streams of water could have been conveniently conducted near the excavations, for the purpose of washing the gravel.

8. The guide stated, that crystals of tin could be in this manner separated by the hand, without the usual aid of the washing-trough. The rains not being at that time sufficiently advanced for that purpose, I did not succeed in obtaining any tin from the pits. The line of deposit of the richest stanniferous gravel has been probably influenced by many causes, and the chances of finding it are much the same as those to which other undertakings of this nature are subject. A few trials, however, across the low ground, through which the hill streams pass, would enable the speculator to follow its course.

9. The time of the tin washer was, I found, much better occupied in seeking for tin in the bed of the river. He was assisted by one man, who disturbed the sand and gravel with his feet to as great a depth as he could thus accomplish; when a conical and shallow trough about two feet in diameter and ten inches deep was filled with the same, and washed in the stream by a circular motion so as to get rid of the gravel and lighter particles, leaving the crystals of tin to collect by their gravity on the apex of the hollow trough. Each filling and washing occupied on an average, six minutes.

One washing produced 1041 grains of native peroxide of tin in six minutes, Specimen, No. 2, equivalent to 1 oz. and 335 grains of pure tin.

One ditto ditto, 1265 grains of ditto ditto, Specimen No. 3, equivalent to 2 oz. and 31 grains of pure tin.

One ditto ditto, 1785 grains of ditto ditto, Specimen No. 4, equivalent to 2 oz. and 430 grains of pure tin.

One hour's work apart from the above, 8166 grains of ditto Specimen No. 5, equivalent to 13 oz. and 160 grains of pure tin.

Total of half a day's work including the above, 25,406 grains, equivalent to 2 lbs. 9 oz. and 232 grains of pure tin.

Specimen No. 6, contains of the latter 13,149 grains.

The price of labour in this province is six annas per day.

10. The produce of a day's labour of two men would be, according to the above trial, equivalent to 5 lbs. 2 oz. and 464 grains of pure tin, at the cost of 12 annas, exclusive of the expenses of reduction to the metallic state. This process, from the pure state of the mineral, is extremely simple and inexpensive. The tin collected in the trough would require one more washing to remove particles of sand, &c. and charcoal is the only fuel required for its reduction. The pieces or ingots of tin, in the shape of the frustrum of a cone, Specimens Nos. 7 and 8, which are manufactured at the Rehgnon mines on the Pak Chaw river to the southward, and exchanged there for goods at 4 annas each, weigh 1 lb. 2 oz. and 383 grs.; and their value at Mergui, where the average price of tin is 85 rupees per 100 viss of 364 lb. is 4 annas 4 pie. The value therefore of 5 lbs. 2 oz. and 464 grains or the day's work of two men would be one rupee eight annas four pie. The cost of collecting being 12 annas, leaves 12 annas and 4 pie for the cost of the reducing process, and for profit on the labour of two men.

11. On the morning after reaching the Thabawliek, I traced the tin ground for a mile in a N. N. E. direction. The pits are in some parts more abundant than in others; and I was informed that they occurred and were thickly scattered throughout the entire course of the river, between that point and the hills from which it issued, at the distance of an entire day's journey if the windings of the river are followed.

12. The pits have not been worked since the Burmese took possession of the country. At the head of the stream, there are said to be the remains of bunds constructed for distributing water for wash-

ing the tin, and the posts of a house still standing, which is supposed to have been occupied by a Siamese Superintendent of the work there carried on.

The season was too far advanced to enable me to prosecute my enquiries towards the hills on this occasion, and my attention was therefore confined to the spot from which I obtained the results detailed above.

13. Four other rivers emptying themselves into the Lesser Tenasserim, are said to produce tin, but none are so accessible as the Thabawliek.

The following are the names of these streams, with their distances from the Thakiet river :—

The Khamoungting river, one day by the Little Tenasserim, and one march in land.

Engdaw river, no road through the jungle.

Kyeng ditto, two days by the river, and two days in land.

Thapyn ditto, three days by the river, and one march in land.

From the Khamoungting, Specimen No. 9, weighing 2890 grains was collected in ten washings, but I did not visit the place myself.

14. After returning to Tenasserim, I visited Loundoungin river, where tin was said to exist, but it turned out to be wolfram sand, which had been washed down from the adjoining slate mountains, and was lying on the surface of the sandy bed of the stream.

15. In proceeding down the Great Tenasserim river towards Mergui, I halted at Moetong, for the purpose of visiting a tin ground, which was said to exist near the range of hills to the N. E. skirting the open plain in which this place is situated. On penetrating to the hill itself, I found it to consist exclusively of granite, with not a trace of another rock of any description. The dry beds of the water-courses consisted of granitic sand alone.

There were many excavations for tin on the face of the hill; several loads of gravel from the bottom of the pits and from the beds of the water-courses were carried to the river and washed, but the out-turn of tin was very small. There is no water within convenient reach.

16. The next spot visited was Kahan, a small hill near the Zedavoun Pagodah, on the right bank of the Great Tenasserim river,

11 miles from Mergui. The tin occurs here under conditions differing much from that of the localities above mentioned.

17. Kahan itself is the highest portion of a low ridge of hills, not more than 200 feet above the level of the river: it is composed of a soft friable white sandstone rock, the upper portions of which are decomposed and irregular. The surface gravel does not contain tin. It is found in the crystallized form interspersed in decomposed granite, forming a vein about 3 feet wide, which is enclosed by the white sandstone rock, and dips down at a high angle with the horizon. Specimen No. 10, if its form be preserved, illustrates well the tin crystals imbedded in the decomposed granite, which are easily detached from the matrix. The Specimen No. 11, from the same vein of yellow colour, is considered the surest indication of the presence of the mineral, and lies below the white, No. 10. Large scales of chlorite occur with it, which as they are generally found where the tin is most abundant, is called by the natives the mother of tin. The face of the hill is in one spot scattered over these, which appear to have been brought down from the vein with other matter from which the tin has been separated by the usual mode of washing. It will be noticed, that the granite is completely decomposed, and that the crystals would be easily separated by washing. No tin has been raised here since the country came into our possession, but the locality has been known. It was worked during the Burmese rule, and valued as supplying the richest ore of tin. A Burmese residing near the spot, pointed out the place where his operations had ceased. He had followed the direction of the vein alluded to, as well as he was able, and had driven a gallery under ground in an inclined direction upwards, till the bank above fell in, when the mine was abandoned. He stated that he had procured considerable quantities of tin daily, and that he often found it in large masses mixed with yellow ground above mentioned. Arriving at the spot where his work had terminated, I set people to excavate and find, if possible, the vein which had been described. It was reached after about two hours' digging, at the depth of five feet from the surface of the cut in the hill in which we stood. In about a quarter of an hour, a few baskets of the decomposed granite were removed down the hill, from which 3900 grains of the crystallized peroxide of tin, equal to 63.176 grains of pure tin,

Specimen No. 12, were collected; and the next day 23400 grains, equal to 2 lb. 6 oz. and 200 grains of pure tin were found in the same manner by one man's labour in excavating, one carrying down to the water, and a third washing.

18. This locality appears to be of very promising description, and I have little doubt that if the work were aided by ordinary skill and means, that a tin mine here would be productive. A vein of tin is, in fact, exposed to the day, and would only require for a considerable period of work the precaution of well supported galleries and shafts, to allow of its contents being easily extracted.

19. The Kahan hill is I conceive an indication of a valuable repository of tin. It is but quarter of a mile from the creek communicating with the river, which is accessible to any boats. Its proximity to Mergui offers also great facility for the procurement of labour and supplies.

20. The localities therefore which appear to hold out the best prospects for tin are, 1st, for stream tin, the Thabawliek river and the Thengdan river; and 2d, for mine tin, the Kahan hill. They all produce tin of the same nature and quality; viz. crystals of the native peroxide, being a combination of oxygen and tin only.

21. No difficulty would be found in procuring labour from Mergui, or carrying on tin works at either of these places.

22. Of the existence of tin in considerable quantities, there cannot, from the facts above stated, be much question; and from the trial of the produce of one man's labour in a given time, there appears to be sufficient to justify every expectation of a profitable employment of labour on an extensive scale.

23. The results, however, which are given in detail, can only be considered rough approximations to the probable out-turn of tin, with an establishment properly superintended. Much economy in labour might be effected in collecting the sand and gravel for the washers, but no better mode could, I think, be adopted in separating the tin in the first instance, than by people accustomed to work with the flat conical-shaped troughs before described. The quantity collected would fully repay the employment of men in this operation.

24. The tin as produced by the washers should be placed on sloping boards, and water conducted over it from a trough pierced with holes

for the purpose, in order to get rid of foreign particles, and it would then, after by being finely pounded, be ready for smelting. Of all metals, tin is in this process the least troublesome after the ore is freed from the earthy and silicious particles with which, in other countries, it is often mixed. The crystallized form in which the ore is here found, renders its separation extremely easy, and the whole processes of stamping and dressing, which in England are tedious and expensive operations, can thus be dispensed with. No arsenic or sulphur being mixed with the ore, it need not be roasted before it is placed in the furnace.

25. It will thus be seen, that the tin of the Mergui province offers no ordinary inducement to the outlay of capital, without much of the risk, uncertainty, and large previous outlay usually attending mining adventures.

26. The location of the coal mine on the Great Tenasserim river, has given rise to much additional cultivation along the banks of that river, where there are many Kareen villages, from which parties on the Thengdan could be supplied. Fruit trees, not indigenous to the place, and other traces of a considerable population having once occupied its banks, are observable on this river. The banks of the Little Tenasserim are thinly occupied by Siamese villages. The country in this direction, except near the banks of the river, is utterly unpeopled, and appears always to have been so.

27. Communication by water from the Thakiet to the Thabawliek tin ground is not open in the dry season, but the distance by land is short. The produce of two lines of country, that of the vicinity of the Great and Little Tenasserim river passes the town of Tenasserim at the junction of these rivers, only eleven miles from the Thakiet, and no difficulty in procuring subsistence for working parties on the Thabawliek need be apprehended.

Although stream ore is worked with advantage in Cornwall, we believe it is Mine-tin ore that is chiefly worked at Banka, and other parts of the Dutch possessions, in the Straits, with so much advantage. As mine ore occurs under favourable circumstances at Kahan, a hill described by Captain Tremenheere on the right bank of the Great Tenasserim, only eleven miles from Mergui, the Coal and Mineral Committee, to which this report has been referred by the Government, were of opinion that the ore might be worked in that locality, with every prospect of success.—Ed.

On the Manganese of the Mergui Province. By Captain G. B. TREMENHEERE. Plate ii.

1. During my stay at the Tenasserim coal basin, a piece of manganese ore, (black wad) of good quality, was brought to me by a Kareen, who stated, that it had been found accidentally in the bank of a stream called the Thuggoo, which enters the Great Tenasserim, seventeen miles below the coal site. Subsequently, several other pieces of the same ore were brought by Mr. T. A. Corbin, Assistant to the Commissioner from the Therabuen river, five miles above the Thuggoo, and from an intermediate spot, the locality of which had been previously known, and had been, I believe, originally pointed out by Lieutenant Glover of the Madras Army.

2. In proceeding down the river, I visited these spots, and found at each, that a valuable bed of manganese ore existed close to the surface of the country. It had been apparently cut through by the action of the stream and river before mentioned, leaving a section of the bed of ore in their banks, covered only by the debris of the banks themselves. Large quantities might have been carried away, but a few hand specimens only were taken, which sufficiently shew the nature of the deposit, and are fair samples of what might be easily collected.

3. The best Specimens, Nos. 1 and 2, are from the Thuggoo river and the bank of the Great Tenasserim. That of the Therabuen did not appear to be at the surface of so pure a quality, but the existence of the bed being known, it is perhaps premature to pronounce it an inferior ore from the examination of specimens taken from a hole extending not two feet into the bank. No. 5, is a portion of manganese rock projecting into the Great Tenasserim river, near the mouth of the Therabuen stream.

4. For the localities above mentioned, I must refer to the sketch accompanying my Report on the tin of this province, recently forwarded.

5. Of the extent of these manganese beds it is difficult to pronounce. The face of the country in which they are situated is flat, thickly overspread with soil, and with the densest jungle. It is not, as far I could perceive, intersected by many streams which would afford

the means of tracing the mineral deposit. The Great Tenasserim river has passed through the manganese bed in one spot, 2½ miles removed from two other points at which it occurs to the north and south, at both of which it is likewise discovered near the surface by the action of the streams Thuggoo and Therabuen. The probability therefore, is, that it is an horizontal deposit covering many square miles. But without indulging in conjecture, there is sufficient at the localities referred to, to indicate large quantities of manganese ore which could be collected by penetrating through the soil lying above it, and immediately near the spots in which it is now exposed to the day.

It occurs in the form of the black oxide, and is the manganese of commerce. It is largely consumed in Europe in the preparation of bleaching compounds, and when pure, is valuable to the manufacturer of glass.*

6. The soft black ore, No. 1, is a hydrate of the peroxide of manganese, known under the name of wad. It contains of water two equivalents, or 29 per cent.

Iron, 1.96 grains by analysis; its specific gravity is 1.47.

The specific gravity of the grey peroxide, No. 4, is 1.46.

Moulmein, 11*th September,* 1841.

Muscologia Itineris Assamici; or a Description of Mosses collected during the Journey of the Assam Deputation, in the years 1835 *and* 1836. *By* W. GRIFFITH, ESQ. *Assist. Surgeon, Madras Estabt.*

(Continued from page 514, vol. ii.)

BRACHYMENIUM, HOOK. BRID. BRYOL. UNIV.

1. *Brachymenium contortum,* Griff.

Caule brevi simplici vel fastigiatim ramoso, foliis siccitate contortis, oblongo-lanecolatis marginibus incrassatis apicem versus denticulatis, capsula erecta elongato-obovato-pyriformi.

Hab: Super arbores pinetorum Moflong.

Caulis brevis, vix bilinealis, innovationibus ramosus, et sæpius dichotomus. Rami erecti, simplices, caule paullo longiores.

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* It is used in the fumigation of ships, and has hitherto been imported for the purpose from Europe. An application has been made to Capt. Tremenheere for a few maunds as a sample, and if the Tenasserim manganese is found to answer, the article may be omitted in future indents on Europe for Medical Stores.—ED.

Folia siccitate valde contorta, leniter tortilia, marginibus-valde revolutis humore patenti-ascendentibus, interdum leniter contorta summa subrosaceim patula, interdum obovata, marginibus leniter revolutis (apices versus exceptis fibrosis, sursum attenuatis et apices versus denticulatis, percursa vena in cuspidem subulatam folio aliquoties breviorem scabram excurrente-areolis conspicuis.

Flores monoici vel dioici; masculi terminales gemmiformes, cincti foliis caulinis terminalibus et ideo quasi discoidei, foliisque perigonialibus conniventibus multo minoribus, ovato-rotundatis, apiculatis simili modo, concavis.

Paraphyses plures hyalinæ filiformes.

Antheræ plures subsessiles-oblongo, cylindraceæ, areolatæ, apice dehiscentes.

Flores fæminei terminales discoidei.

Paraphyses pistillaque plurima.

F. Perichæltalia consimilia, interiora minora. Seta terminalis, sæpius e dichotomia uncialis vel sescuncialis, rubra, sicca flexuosa tortilisque, humore paullo flexuosa.

Vaginula longiuscula, subcylindrica, paraphysibus hyalinis filiformibus pistillisque pluribus obsita.

Capsula erecta cum apophysi longa capsula paullo breviore obconica, obovato-pyriformis, brunnea, ore valde constricto, lucido, rubro, annulato. Membrana interna leviter adnata.

Peristomii dentes operculo detruso primo per paria cohærentes, demum erecto discreti, æquidistantes, reflexo-patentes, mediocres, pallidi, apicibus albidi opaciusculi, linea longitudinali notati, trabeculati, capsulæ firme adhærentes.

Interius e membrana areolata punctulato-opaciuscula, sedecies carinata, carinis dentibus peristormii exterioris alternis paull prominulis, obtusis, ultra interstitia quæ plerumque bidentato breviter productis ; dentes interstitiorum interdum (mora Bartramiæ) conniventes. Membrana secus carinas facile findie tur.

Sporula viridescentia, majuscula, lævia, immersa globosa opaciuscula.

Columella truncata, inclusa.

Operculum diu persistens, conicum, obtusum cum columellæ apice secedens.

Calyptra desiderata.

An. B. nepalense, Schwaeg; Brid. Bryol. univ. 1.602 ?

Habitus illi Leplostomo, RBr. certe affinis.

2. *Brachymenium cuspidatum*, Griff.

Caule brevi ramoso, ramis cylindraceis fastigiatis, foliis lanceolatis acuminatis integerrimis, vena excurrente cuspidatis, marginibus simplicibus, capsula suberecta obovato-pyriformi.

Hab : In sylvis Myrung.

Caulis primarius brevissimus, innovationibus ramosus. Rami erecti, breviusculi, vix semunciales, sicci filiformes, humore squarrosuli. Folia siccitate adpressa, humore ascendenti-patentia, concava, valde acuminata, vena excurrente in cuspidem brevem subulatam patentem prædita, areolis fusiformibus.

F. Perichætialia magis acuminate oblongiora, marginibus subincrassatis. Seta terminalis, uncialis, vel ultra, flexuosula, rubescens, sicca tortilis. Vaginula brevis, conico-ovata, obsita paraphysibus hyalinis filiformibus pistillisque numerosis.

Capsula erecta vel paululum inclinata, cum apophysi longe obovato-pyriformis, rufo-brunnea,—fere Br. contorti, sed minor.

Peristomium exterius e dentibus 16, erectis, imis apicibus subrecurvis, trabeculatis, linea longitudinati notatis, rubris, apicibus opacis lutescentibus.

Interius e membrana alta, sordide lutescente areolata, sedecies plicata, plicis exeuntibus in dentes breves irregalares, (interdum in cilia,) fissis plerumque divaricatis et dentibus p. exterioris oppositis, sinubus sæpius nudis.

Sporula minuta, lævia, immersa diaphana.

Culumella inclusa, filiformis, truncata.

Operculum conicum, obtusum.

Calyptra desiderata.

An B. bryoides, Schwaeg. Brid. Bryol. univ, 1. 603 ?

3. *Brachymenium filiforme*, Griff.

Caule ramisque elongatis filiformibus, foliis arcte adpressis ovatis muticis mediatenus 1-veniis, capsula cernua vel pendula.

Hab: In ripis Maamloo; in rupibus inter Surureem et Moleem et ad cataractam Moosmai.

Cæspitosum, argenteo canescens; caules basi decumbentes, subclavati, apicem versus innovationibus ramosus, ramique simplices, interdum longissimi, sæpe fastigiati. Folia dense imbricata, sicca madidave arcte adpressa, obtusa vel acutiuscula, integerrima, vel minutissime denticulata, marginibus simplicibus, vena mediocri medium versus evanida donata; areolis fusiformi-angulatis.

Perichætialia exteriora caulis terminalia sed acutiora, interiora minora.

Seta terminalis, uncialis, vel ultra, rubescens, siccatione etortilis. Vaginula brevis, conica, paraphysibus pistillisque pluribus obsita. Capsula cum apophysi mediocri obconica (capsula 3-plo breviori) obovata, brunnea, ore constricto rubro annulato.

Membrana interna libera.

Peristomium exterins connivens, e dentibus 16 angustis, plano-subulatis, sordide et pallide rubris, acuminibus setaceis albidis, subhyalinis, linea longitudinali inconspicua sæpius notatis trabeculatis. Interioris membrana alta, solida, areolata, sordide lutescens, sedecies carinata, carinis dentibus p. exterioris more solito alternis, productis in dentes irregulares breves, vel longiusculos, setaceos, rarius perforatos, interdum si breves, fissos, laciniis divaricatis. (ut in Bartramia.)

Sporula minuta, lutescenti-viridia, immersa diaphana.

Columella, inclusa puncata.

Operculum conicum, obtusum, rubrum, obliquiusculum.

Calyptra desiderata.

BRYUM, LINN.

1. ***Bryum argenteum, Linn.*** Hook.

Hab : Saxa ad Surureem et Nunklow.

2. ***Bryum cœspiticium, Linn.***

Hab : Rupes, Churra Punjee et Surureem. Super arborem delapsam Suddiya.

3. ***Bryum coronatum, Schwaeg*** **: Brid. Bryol. univ. 1. 650.**

Hab : Colles Khasiyani ; locus nobis ignotus.

Planta Khasiyana descriptioni Bridelii l. c. apte quadrat.

4. ***Bryum crudum,*** **Huds. e Musc. Brit.**

Hab : Terreste. Pineta Moflong.

Variat statura : Caules sæpe innovationibus ramosi, folia sæpe plus minus destructa, vena continua etiam subexcurrente prædita, innovationum latiora brevioraque. Flores hermaphroditi.

5. ***Bryum coriaceum,*** **Griff.**

Caulibus sterilibus repentibus, fertilibus erectis simplicibus, foliis terminalibus rosaceo congestis obovatis emarginatis denticulasit, setis aggregatis, capsula cylindraceo-oblonga cernua, operculo longe et oblique rostrato.

Hab : Rupes humidi maamloo, ubi copiosum.

Caules steriles ramosi, flagelliformes, fertiles sæpius simplices, subunciales, basi denudati, radiculoso-villosi.

Folia caulium fertilium crassa, coriacea, emarginata, sinu mucronigero, marginibus diaphanis lutescentibus e cellularum difformium sub-triplice serie conflatis, percursa vena subulata completa vel intra apicem evanida sæpius centro linea fuscescenti notata percursa, areolis majusculis sub-6-gonis sæpe aer continentibus; inferiora magis rotundata, et vix emarginata.

Caulium sterilium folia inferiora aliis conformia, superiora rotundata vel orbicularia, repanda.

Perichætialia exteriora caulina terminalia, interiora minora, intima minima, acuminata, integra.

Flos terminalis, hermaphroditus

Antheræ plures. Pistilla numero varia.

Paraphyses copiosissimæ, hyalinæ, filiformi-clavatæ.

Seta pallida, raro solitaria, sæpius 2-3, aliquando 6, aggregatæ sescuncialis, sicca parce tortilis.

Capsula cernua vel nutans, sæpius horizontalis, fusco-viridis immatura tantum visa.

Peristomium exterius e dentibus 16, latis, breviusculis, trabeculatis, linea longitudinali obsoleta notatis.

Interioris membrana lutescens; ciliis ample perforatis, ciliolis binis ternisue cohærentibus interjectis.

Operculum e basi convexa longe et oblique rostratum, (rostro sæpius incurvo) capsula dimidio brevius.

Calyptra longe subulata, hinc fissa.

Medium quasi tenet inter B. punctatum et affine.

6. *Bryum Sollyanum*, Griff.

Caule repente, ramis erectis, foliis terminalibus, rosaceo-congestis obovatis acuminato-cuspidatis marginatis, marginibus medium infra revolutis integris supra planis argute serrulatis, vena intra apicem subevanida, capsula oblongo-cylindracea cernua, operculo acute mammillari.

Hab: In sylvis Surureem, et copiose in pinetis Moflong.

Rami erecti, unciales vel ultra, inferne nudiusculi radiculoso-villosi, interdum apice vel infra proliferi.

Folia rosaceo-patentia, confertissima, maxima, semuncialia, vel ultra, lalitudine extrema fere 3-linealia, breviter acuminato-cuspidata, cuspide semi-torta, argute serrulata, dentibus serraturis sæpe biseriatis, percursa vena crassa sursum attenuata intra apicem subevanida, læte viridescentia, areolis anguste hexagonis siccitate flexuosula interdum subtortilia.

Flos hermaphroditus fæmineusve, terminalis, vix discoideus, cinctus foliis perigonialibus caulinis multo minoribus, erectis, lanceolato-linearibus linearibusve, carinatis, acuminatis, acumine in subulam scabrellam longam exeunte, marginibus subsimplicibus infra medium insigniter revolutis, sursum planis obsolete denticulatis, vena basin acuminis versus evanida.

Antheræ plurimæ, clavatæ, breviter stipitatæ, apice dehiscentes, celluloso-areolatæ.

Paraphyses plurimæ, hyalinæ, filiformes, æqualiter septatæ. Pistilla floris hermaphroditi pauca, fæminei copiosa, 2-3 sæpius fecundata.

Seta terminalis, sæpius binæ termæve, 1½ vel 2-uncialis, rubescens.

Vaginula ovato-conica, mediocris.

Capsula raro pendula, sæpius subtransversa, maxima, longitudine trilinealis, oblongo-cylindracea, inæquilateralis, basi solida, demum brunnea, collo parum constricto, ore annulato.

Membrana interna libera.

Peristomium exterius connivens, e dentibus 16, magnis, plano subulatis, utrinque trabeculalis, lineis compositionis albis conspicuis notatis pallide rubris, acuminibus setaceis albidis.

Peristomuim interius e membrana lutescente altiuscula, insigniter sedecies plicata, ciliis valde acuminatis, crebre ampleque perforatis punctulatis ; ciliolis interjectis hæc subæquantibus tenuissimis, sæpius ternatis conspicue trabeculatis.

Sporula minuta, viridescentia, globosa, lævia, immersa opaciuscula. Columella longe apiculata, inclusa; operculum concolor. Calyptra desiderata.

Species præ aliis ampla et palchra.

B. Umbraculo proximum. Hook; Musc. exot. p. 16. t. 133.

7. *Bryum longirostrum*, Griff.

Cuale sterili repente, fertili erecto, foliis (terminalibus) rosaceo-congestis oblongo-ligulatis obtusis marginatis denticulatis vena in mucronulum excurrente, setis aggregatis, capsula cernua cylindraceo oblonga, opercula longe et oblique rostrato.

Hab: In arboribus vel ripis sylvarum, collium Khasiyanorum inter Churra Punjee et Nunklow.

Folia omnia subconformia, siccitate crispata, sæpius recurvata et carinata, oblongo-vel spathulato-ligulata.

Perichætialia intima, minima.

Setæ aggregatæ 2-8, capsulæ sæpius horizontalis, inæquilateralis, annulata.

Peristomium exterius humore connivens, pallide lutescens; dentes plano-subulati, breviusculi, trabeculati.

Interioris membrana solito saturatius lutescens, ciliis acuminatis valde poratis, ciliolis simplicibus binisve interjectis.

Sporula globosa, lævia, immersa opaciuscula.

Columella longiuscule apiculata, inclusa.

Operculum e basi convexa longe et oblique rostratum, capsula $\frac{1}{3}$ brevius, lutescens, margine rubrum.

Calyptra longe subulata, apice uncinata, ad medium usque fere fissa.

A B. ligulato, vix distinguendum operculo longiro-nisistro, et floribus hermaphroditis ?

PTEROGONIUM, HOOK.

1. *Pterogonium squarrosum*, Griff.

Caule repente pinnatim ramoso setigero, ramis erectis simplicibus, foliis siccatione adpressis humore patentissimis late ovatis valde concavis breviter apiculatis integris aveniis, capsula erecta oblongo-ovata, operculo conico-subulato.

Hab: Super arbores sylvarum Tingrei vicinitatisque Suddiyæ.

Rami siccatione sæpe depressi, apice interdum elongati.

Folia dense et undique imbricata, late ovata, interdum suborbicularia, breviter acuminata, apices versus fusco-tincta, areolis angustis fusiformibus, basilaribus utriusque lateris ampliatis subquadratis.

Perichætialia lanceolato-oblonga, acuminata, acuminibns exteriorum et minorum patentissimis vel recurvis, interiorum rectis.

Seta vix semuncialis, pallida, sicca parce tortilis.

Vaginula subcylindracea, pallida. Paraphyses plures, tenues, filiformes. Pistilla pauca.

Capsula exannulata, albida, æquilateralis.

Peristomium e dentibus 16, plano-subulatis, acutis, binatim compositis, linea longitudinali transversisque distinctis, interdum apices versus obsolete perforatis, sub lente centies augente obscure striatis, badio-rufis, apicibus diaphanis ; serius albidum, fragile.

Sporula magna, valde inæqualia, rotundata.

Columella apiculata, inclusa.

Operculum leviter inclinatum, obtusius culum.

Calyptra profunde dimidiata, lævis.

Affine Pterogonio Myuro, Hook. Musc. exot. p. 9. t. 148, a quo præcipue differt caule repente, ramis erectis squarrosis approximatis, foliisque acuminatis.

2. *Pterogonium aureum,* Hook. Musc. exot. p. 8. t. 147. Brid. Bryol. univ. 2. 180.

Hab : Super arbores—Mumbree.

Folia plantæ Khasiyyanœ multo magis patentia quam demonsrat Hookeriana icon.—Capsulas seniores tantum vidi, quarum peristomia decolorata. Præcedenti valde affine, discrepans foliis minus patentibus, membranaceis, lanceolato-acuminatis, marginibusque recurvis.

3. *Pterogonium flavescens,* Hook. Musc. exot. p. 8. t. 155. Bridel. Bryol. univ. 2. p. 193.

Hab : Super arbores Myrung.

Omnia fere plantæ nepalensis, sed statura major, et ramificatio indistincte pinnata. Variat dentibus peristomii solidis perforatisve.

4. *Pterogonium neckeroides,* Griff.

Caule repente pinnatim ramoso, ramis ascendentibus, foliis ascendenti-patulis lanceolato-acuminatis planiusculis tenuissime semi-veniis subintegris, capsula obliqua cylindracea inclinata annulata, operculo conico-subulato brevi.

Hab : Super Buddleæ speciem arboream Mumbree.

Rami depressi, siccatione filiformes. Folia sub-4-fariam imbri cata, siccitate adpressa, humore patentia, marginibus medium infra leviter revolutis, areolis angustis, marginalibus baseos majusculis quadratis.

F. Perichætialia avenia, acuminibus patulis.

Seta axillaris, solitaria, vel aggregatæ, sed ad inflonescentias diversas semper pertinentes, pallida, sicca tortilis ; vaginula mediocris, cylindracea ; paraphyses pistillaque paucissima.

Capsula cylindracea, inæquilateralis, utrinque paullo attenuata, brunneo-rufescens.

Peristomii dentes 16, subulati, simplices, breviusculi, coriacei, solidi, lutescentes, marginibus valde opacis, utrinque marginati.

Sporula majuscula, vix uniformia, globosa, lævia viridescentia, immersa opaca.

Columella filiformis, inclusa, apiculata; operculum obliquiusculum.

Calyptra non visa.

Variat statura.

NECKERA.

Hedw. ex pte. Bridel. Bryol. univ. *2. 226*, ex pte.

1. *Neckera curvata*, Griff.

Caule repente pinnatim ramoso, ramis apice attenuatis curvatis, foliis undique imbricatis late ovatis ovatisve-breviter acuminatis minutissime denticulatis sæpius aveniis, capsula erectiuscula cylindracea leniter arcuata, operculo concico subulato.

Hab: Rupestris prope torentem Bogapanee collium Khasiyanorum.

Caulis elongatus. Rami siccitate filiformes, madidi subcyliudracei. Folia subquadrifariam imbracata, siccitate appressa, humore ascendentia, concaviuscula, sub-lente forti minute denticulata, avenia vel basi brevissime bivenia (potius bistriata,) fuscotincta, caulinia late-ovata, acuminata, ramena ovata, acuta vel breviter acuminata.

F. Perichætialia exterioria conforma, recurva, interiora majora, oblongo-lanceolata, valde acuminata, recta, subintegra.

Seta lateralis, aucialis vel paullo longior, rubro—sanguinea sicca torta.

Vaginula oblongo—cylindracea pallida. Paraphyses hyalini, filifomes, plures. Pistilla pauca.

Capsula obliquiuscula, leviter arcuata, anguste cylindracea, ferrugineo-brunnea.

Membrana interna libera, stipitata:

Peristomium utrumque cum membrana interna scedens, exterius e dentibus 16, plano-subulatis, binatim compositis, solidis, rigidis, fragilibus, conniventibus, etrabeculatis, infra medium rufis, supra idem lutes centibus. Interius e ciliis totidem altenantibus, brevioribus, setacies, binatim compositis, solidis, pallide lutescentibus, diaphanis, basi unitis in membranam perbrevem.

Columella subcylindracea, apiculo persistente exerto.

Sporula viridescentia, globosa, lævia, mixta cum massis ovatis, aliquoties majoribus, compositis, in membrana hyalina inclusis.

Operculum conicum, obtusum, capsula fere 4-plo brevius.

Calyptra lævis, demidiata.

Habitus omnino Hypni.

2. *Neckera lurida,* Griff.

Caules repente subpinnatim ramoso, foliis undique imbricatis ovato-lanceolatis brevissime acuminatis cymbiformibus basi obsolete biveniis integerrimis, capsular oblongo cylindracea basi subapophysata operculo conico.

Hab: Rupes Surureem.

Caules elongati repentes, subpinnatim ramosi, sæpe denudati. Folia undique imbricata, patulo-ascendentia, acuta, cymbiformia, marginibus leviter involutis, basi obsolete biveniis.

Perichætialia fere præcendentis.

Seta præcedente paullo brevior, apice in apophysi obsoletam incrassata.

Capsula inclinata, leviter arcuata, obliquiuscula, rubra incomplete annulata.

Columella, sporulaque præcendentis.

Peristomii exterioris dentes fere ut in præcedente, sed duplo breviores magisque evoluti et trabeculati.

Interius e ciliis totiden alternantibus, inferne obsolete carinatis, brevioribus vel subæquantibus, lutes centibus, diaphanis, basi unitis in membranam brevissimam (vix demonstrandam) dentium peistomii exterioris basibus arcte cohærentem.

Calyptra—

Præcedenti, quamvis habitu sat distincta, proxima.

An species Anomodanti et Hookeri et Taylori.

3. *Neckera pulchella,* Griff.

Caule repente pinnatim ramoso, ramisque subcomplanatis, foliis undique imbricatis lanceolatis acuminatis, concavis, basi bistriatis apicem versus minute denticulatis, capsula cylindracea leniter arcuata, peristomio interiore tenerrimo, operculo conico-subulato.

Hab: Sylvæ Mumbree.

Species pusilla. Rami præsertim siccitate complanati, depressi. Folia undique imbricata, lateralia disticha, concava incurva, acuta, basi inconspicue bivenia, areolis angustis, basilaribus utrinque laxis et quadratis, marginibus subincurvis.

Flos fæmineus axillaris, gemmiformis, cinctus foliis perichætialibus conniventibus acuminibus patulis, interiorum longissimis rectis vel subtortilibus. Pistilla circiter 12. Paraphyses magis numerosæ hyalinæ, longiores.

Seta axillaris, lineas tres vix excedens, rubescens, sicca valde tortilis. Vaginula mediocris, pallida, ore membranaceo.

Capsula suberecta, obliquiuscula, annulata, brunnea.

Peristomium exterius e dentibus 16, humore incurvis, plano-subulatis, breviusculis, vix trobeculatis, transversim crebre lineatis, linea longitudinali inconspicuâ, valde fragilibus, pallide rubro-brunneis, acuminibus hyalinis. Interioris cilia breviora, alba, utrinque repanda, fere moniliformia, tenerrima, fragillima, membrana basilari tenuissima dentibus peristomii exterioris cohærente.

Sporula mediocria, rotundata, fusco-viridescentia, immersa semi-opaca.

Columellæ apiculus acutissimus, primo exsertus.

Operculum subulatum, rostro curvato, capsula vix duplo brevius.

Calyptra profunde dimidiata, lævis.

Medium quasi ambigit inter N. curvatam et N. lætam, præcipue hujus varietatem A. e qua tantum differt statura minore, ramis minus complanatis, operculo longiore peristomioque interiore tenerrimo.

Dentis peristomii exterioris fere ut in Pterogonio.

4. *Neckera læta*, Griff.

Caule repente pinnatim ramoso, ramis complanatis, foliis lanceolatis acutis integerrimis basi sæpius bi-tri-striatis, capsula erecta cylendracea, operculo subulato.

Hab: Super arborem lapsam prope cataractas "Moosmai." Loci editî Assamici prope Suddiyam et Negrogam.

Folia undique imbricata, antica posticaque adpressa, literalia disticha, ascendentia, concaviuscula, pallide viridescentia.

Flores masculi axillares, gemmiformes. Fol perigonialia exterioria rotundata, interiora oblongo acuminata, acumine patente ascendente.

Paraphyses paucæ, hyalinæ, antherarum longitudine. Antheræ plures, circiter decem, subsessiles, apicibus dehiscentes, inconspicue saltem post dehiscentiam areolatæ.

F. Perichætialia acuminata, acuminibus exteriorum recurvis, interiorum ascendenti-patentibus.

Seta axillaries pallida, subuncialis, sicca tortilis. Vaginula brevis, pallida, ore rubro. Paraphyses hyalinæ, filiformes.

Pistilla pauca, stylis longis.

Capsula anguste cylindracea, basi solida, subæqualis, pallida, sub lente modice augente areolis quadratis reticulata, ore lævi, rubro, exannulato.

Membrana interna adnata.

Peristomium exterius humore connivens, siccitate erectum, breve; dentes binatim compositi, subulati, rigidi, fragiles, vix trabeculati, castaneo-brunnei.

Interius e ciliis totidem, subconcoloribus, solidis, brevioribus, diaphanis, basi in membranam mediocrem sursum concolorem cum peristomis exteriore leviter cohærentem unitis.

Columella filiformis, apiculo semi-exserto.

Sporula subuniformia, lævia, immersa subdiaphana.

Operculum obliquiusculum, alatum capsula sub 5 plo-brevius.

Calyptra profunde dimidiata, lævis, apice stylifera.

Variat :

A. ramis magis complanatis, foliis estriatis, (an semper ?) Peristomii exterioris dentes siccitate ascendenti-patentes, longiores perforati.

Hab : Negrogam et Suddyia.

An distincta ob dentes p. exterioris perforatos (characterem insolitum) coloremque.

B. Fuscescens.

Hab : Nunklow.

5. *Neckera brevirostris*, Griff.

Caule repente, ramis complanatis ascendentibus apice valde attenuatis, foliis ouatis lanceolatisve cuspidato-acuminatis concavis marginibus revolutis subintegerrimis basi sæpius bistriatis, capsula cylindracea inclinata, opercul to conico subulato rostro curvato.

Hab : Arbore Surureem.

Rami aseendentes, simplices, ambitu lineari-lanceolati, apicibus valde attenuati, basi sæpius setigeri.

Folia sub 4-fariam laxe imbricata, basi concaviuscula, lanceotata, valde acuteque acuminata, sublente forte minute denticulata, raro prorsus avenia ; partis rami attenuati minora, falcatim-incurvata, disticha. In axillis foliorum inferiorum adsunt appendiculæ, longissimæ, tenuissimæ filiformes, septatæ, paucæ, utrinque leviter attenuatæ, articulis vel omnino materia grumosa velpartim materia coagulata repletis.

F. Perichætialia acuminata, acumine denticulato.

Seta lateralis, 7-8-linealis, filiformis, fuscescens, sicca tortilis.

Vaginula elongata, cylindracea. Paraphyses subnullæ. Pistilla pauca.

Capsula inclinata, apte cylindracea, angusta, exannulata, fusco-brunnea.

Membrana interna adnata, ore carnosiore peristomifero.

Peristomium exterius e dentibus 16, angustis, subulatis humore apicibus patulo-reflexis, inconspicue trabeculatis, lineis transversis subconspicuis, longitudinali inconspicua notatis, albidis, punctulato-opacis.

Interius ; cilia totidem alternantia, breviora, tenuissima, punctulato opaca, basi unita in membranam brevissimam areolatam dentibus peristomii exterioris leviter adnatam.

Columella apiculata, inclnsa, subcylindracea.

Sporula fusco-viridescentia, deformia immersa, majora opaciuscula, minora diaphana.

Operculum fuscescens, e basi conica breviter rostratum ; rostro obtuso, ut plurimum incurvo.

Variat. A, Ramis erectis, foliisque augustioribus striatis, appendiculis copiosissimis oculo nudo villos ferrugineos mentientibus valde conspicuis, capsula oblongo-cylindracea, operculoque longiore.

Hab : Pineta Moflong.

Appropinquat sectioni ultimæ.

6. *Neckera rostrata,* Griff.

Caule repente subpinnatim ramoso, ramis ascendentibus brevibus, foliis undique imbricatis lanceolatis valde acuminatis concavis, sub integerrimis aveniis, capsula inclinata cylindracea, operculo conico-subulato inclinato capsulam fere æquante.

Hab : Sylvæ Myrung, ubi muscis aliis mixta viget Super pinum vicinitate Myrung frequentissima.

Arborea, cæspitosa. Folia, etiem sicca, palenti-ascendentia, plurifariam imbricata, marginibus subrevolutis.

Perichætialia interiora recta, acuminatissima.

Seta lateralis, rubescens, vix uncialis.

Vaginula arcta. Paraphyses pitillaque pauca.

Capsula inclinata, æqualis, cylindracea, utrimque paullo attenuata, brunea, exannulata.

Membrana interna adnata.

Peristomium exterius siccitate apice inflexile, e dentibus 16, binatim compositis, linea longitudinali notatis, trabiculatis, subulato-setaceis, longis, apicibus opaciusculis.

Interius : Cilia totidem alternantia, conniventi-erecta, angustissima, opaciuscula illis paullo breviora : membrana basilaris brevis basi peristomii exterioris cohærens.

Columella inclusa, apiculata.

Sporula inæqualia, rotundata, lævia, immersa diaphana.

Operculum e basi conica longe et oblique subulatum.

Calyptra dimidiata, lævis.

7. *Neckera copillacea,* Griff.

Caule repente, ramis subascendentibus brevibus, folius undique imbricatis lanceolato-acuminatis aveniis apicem versus minute denticulatis, seta longissima capillacea, capsula erecta urceolato-ovata, operculo conico subulato obliquo brevi.

Hab : Super arbores sylvarum Surureem rara.

Folia ascendenti-patentia, concava; perichætialia oblongo lanceolata, acuminibus denticulatis.

Seta 1½ uncialis, pallida, flexuosa.

Capsula erecta, æqualis, fusco-brunnea, exannulata.

Peristomium utrumque album; exterioris dentes siccatione undulati, plano subulati, obtusi, conniventes, lineis compositionis inconspicuis, opaco-punctulatis, basi unitis in membranam brevem areolatam solidam sedecies plicatam.

Sporula sordide viridia, lævia, immersa opaciuscula.

Columella inclusa.

Operculum conico-subulatum, obliquum, capsula triplo brevius.

Calyptra non visa.

Species distincta, Leskiæ approximans.

8. *Neckera comes,*[*] Griff.

Caule repente subpinnatim ramoso apice attenuato penduol, foliis laxe imbricatis lanceolato-acuminatis aveniis acumine minutim denticulato, seta brevi, capsula inclinata ovato-oblonga, operculo conico-subulato obliquo.

Hab: Colles Khasiyani, inter Churra Punjee et Nunklow. Prope mumbree frequentissima, semper que sodalis.

Caules apicibus sæpius valde attenuati gracillimique, spithamæi, vel paullo ultra, muscis sociis arcte implicati.

Folia palentissima, margine uno involuto, concaviuscula, prorsus avenia, acuminatissima, partium elongatarum disticha et sæpe aristata.

Perichætialia externa rotundata, mutica; interiora caulinis subconformia, acumine ascendente; intima longissime acuminata, rectiuscula.

Seta pallida, curvatula, subbilinealis; vaginula subcylindracea; paraphyses plures, hyalin, filiformes. Pistilla numerosa.

Capsula exserta, æqualis, exannulata, pallide brunnea.

Membrana interna inferne libera.

Peristomium utrumque album, fere hyalinum, humore connivens, ori capsulœ arcte cohærens.

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[*] *Come*—because it always occurs mixed with other mosses.

Exterioris dentes 16, subulato-setacei, linea longitudinali subinconspicua transversisque crebris conspicuis exsculpti.

Interioris cilia alternantia, breviora, submoniliformia, carinata, interdum obsolete perforata, basi unita in membranam brevem, hyalinam, reticulatam.

Columella apiculata, inclusa.

Operculum e basi convexiuscula oblique subulatum, capsula paullo brevius.

Calyptra dimidiata, lævis.

Affinis videtur N. acuminatæ, Hook. Musc. exot. 2. 15. t. 151.

9. *Neckera aurea,* Griff.

Caule repenet, sæpius longissime pendulo pinnatim ramoso, foliis undique imbricatis e basi lanceolata acuminatissimis serrulatis mediatenus-veniis, seta brevissima, capsula subexserta oblongo-urceolata, operculo conico-subulato recto, calyptra mitræformi glabra.

Hab : Pineta Maamloo et Moflong. Margines sylvæ Mumbree, ubi frequentissima aliorumque Muscorum Jungermanniarumque socia.

Fusco-aurea, squarrosa. Caules longitudinis variæ, paullo elongati copiose fructiferi, vel longissimi, pedales quin fere sesquipedales, sæpiusque steriles. Rami plerumque simplices, unciamque vix excedentes. Folia sicca subdisticha, madida palentissima, oblique torta, margine uno basin versus involuto, plus minus undulata, areolis angustissimis, partium attenuatarum disticha apice fere pilifera. Variant angustatione, marginibus subinvolutis, venaque ultra medium evanida.

Flores monœci; masculi axillares, gemmiformes, cincti foliis perigonialibus concavis, ovato-lanceolatis, lanceolatisve acuminatis, integris, aveniis, interioribus minoribus. Paraphyses paucissimæ, 2-3, filiformi-clavatæ, hyalinæ.

Antheræ paucæ, subquinæ, breviter stipitatæ, apice dehiscentes, ore membranaceo irregulari, cellulis sine ordine dispositis, areolatæ.

Folia perichætialia caulinis subconformia, subintegra vel acumine denticulata ; interiora majora, capsulam subæquantia.

Seta brevissima, vix linealis, crassiusculava, ginula ovata, ore brunneo, seta subduplo-brevior, paraphysibus fere expers.

Pistilla pauca.

Capsula suberecta, æqualis, exannulata, setam paullo excedens, fusco-brunnea.

Membrana interna adnata.

Peristomium exterius albidum; dentes plano-subulati, longe acuminati, acuminibus flexuosis, longitudinaliter obsolete transversim magis conspicue notati, vix trabeculati, opaci humore reflexo-erecti. Interius e ciliis totidem ejusdem longitudinis teniussimis, capillaceis, binatim compositis, solidis, punctulato-opaciusculis, basi carinatis et unitis in membranam brevem obsolete sedecies plicatam.

Columella cylindracea, apiculata, inclusa.

Sporula rotundata, immersa opaciuscula.

Operculum lutescens, capsula vix duplo brevius.

Calyptra mitræformis, glabra, basi aliquoties fissa leviterque inflexa, fissura una profundiore.

Habitu præcedenti valde affinis. Variat statura et gracilitate, capsulaque interdum exserta.

10. *Neckera crispatula,* Hook, Musc. exot. 2. 15. t. 151. —Brid. Bryol. univ. 2. 236.

Hab: Colles Khasiyani, inter Churra et Nunklow, super rupes arboresque.

Fructiferam non vidimus.

Muscus hujus sectionis præcæteris speciosus. Caules elongati, sæpe penduli. Folia siccatione adpressa, tri-striata fere tricarinata, leviter flexuosa.

Flos, masculus axillaris, gemmiformis, ovatus. Folia perigonialia concava, avenia; exteriora rotundata, mutica; interiora ovata acuminata, acuminibus ascendentibus vel subpatentibus.

Paraphyses filiformes, hyalinæ, rectæ.

Antheræ circiter decem, subsessiles areolatæ, saturate brunneæ.

11. *Neckera fuscescens*, Hook. Musc. exot. 2. p. 14, t. 157. Pilotrichum fuscescens, Brid. Blyol. univ. 6-224.

Hab : Socia N. aureæ, comitis filamentosæque. Nuperius collibus Naga, Borhauth vicinis, legimus.

Folia quam iconis Hookeranæ, l. c. magis concava.

Flores monœci ? axillares ; masculi gemmiformes, ovati, cincti foliis perigonialibus concavis, ovato-rotundatis vel ovatis, breviter acuminatis, acuminibus rectis vel patulis. Paraphyses plures, hyalinæ, filiformes. Antheræ subsessiles plures, cylindraceo fusiformes, areolatæ-brunneæ. Flores fæminei subcylindracei, gemmiformes ; folia perichætialia inferiora minima, rotundata ovatave, acuta, avenia ; interiora longissima, alba, lineari-lanceolata, acuminata, subintegra vel apices versus minute denticulata, citra medium 1—venia.

Paraphyses paucæ, interdum subnullæ.

Pistilla pauca.—Florem fæmineum, quoad tegumenta, masculo apte similem semel solum vidimus.

Seta brevissima. Vaginula cylindracea, ore brunneo-rubro, paraphysibusque nonnullis longissimis flexuosis rectisve varidque longitudinis stipata.

Capsula immersa, foliis perichætialibus interioribus longe superata.

Membrana interna adnata.

Peristomia infra marginem oris capsulæ subincrassatum exserta.

Exterius humore connivens, castaneo-brunneum, apice pallidum ; dentes plano-subulati, diaphani, lineis compositionis conspicuis notati, leviter trabeculati ; interius e ciliis totidem alternantibus, subæquantibus, a medio infra circiter binatim compositis, setaceis, articulis incrassatis, basi in membranam brevissimam concolorem liberam unitis, p. exterioris dentibus prœteris similibus.

Sporula valde inæqualia, rotundata vel angulata, lævia, immersa, diaphana, in acervulo fusco-viridia.

Columella crassa, sub cylindrcea, apiculo gracillimo incluso.

Calyptra basi aliquoties fissa, fissura una profundiore, villis flexuosis numerosis ascendentibus simplicibus (paraphysibus) paucissimisque compositis eadem directione (foliis abortientibus) obsita. Pistilla etiam gerit.

Variat folliis magis concavis, integris; apiculo productiore tortili; peristomii exterioris dentibus irregularibus linea longitudinali obsolete notatis; interioris ciliis minus evolutis quin interdum simplicibus. Varietas rara, forma foliorum sequenti accedens.

12. *Neckera filamentosa*, Hook, Musc. exot. 2. p. 14. t. 158. Pilotrichum filamentosum, Brid. Broyl. univ. 2. 264.

Hab: Colles Khasiyani, super arbores; muscorum, præsertim vers N. fuscescentis socia. Collibus "Naga," altitudinis circiter 1000-pedalis nuperius legimus, fructifera vers nobis ignota. Inter Churra Punjee et Nunklow.

Flos masculus axillaris, gemmiformis, cinctus foliis perigonialibus conniventibus, valde concavis; exterioribus ovato-rotundatis, muticis vel breviter apiculatis; interioribus majoribus, acuminatis, rectiusculis. Paraphyses copiosæ, breviusculæ, antheras longitudine paullo excedentes, hyalinæ, filiformes. Antheræ breviter stipitatæ, majusculæ, 12-15, oblongo-cylin-draceæ, areolis subquadratis reticulatæ, apice dehiscentes.

Var. A. Statura multo minore, vena longiore, infra apicem evanida.

Fores fæminei gemmiformes, axillares. Folia perichætialia foliis perigonialibus supra descriptis subsimilia, acuminibus scabris sæpius rectis: interioribus minoribus lanceolatis, acumibus denticulatis; intimis minimis, setiformibus scabris.

Paraphyses paucissimæ, hyalinæ, filiformes, articulis sæpe alternatim compressis. Pistilla pauca 8-10, stipitata.

An ita distincta a planta Hookeriana cujus folia perichætialia "obtusa, emerginata, atque pilo longo sub-flexuoso terminata, nervo obscuro; intra hæc folia parphyses numerosæ."

Hab: Loci Assamorum editi, 'Negrogan' vicini.

(To be continued.)

Production of Isinglass on the Coasts of India, with a notice of its Fisheries. *By* J. FORBES ROYLE, M. D.*

Isinglass is a substance well known in commerce, from its employment both in the arts and in domestic economy. It is the purest known form of animal jelly, and is obtained from the swimming bladder of a few kinds of fish, chiefly of the genus Sturgeon, the Acipenser of zoologists. This is indicated by some of its continental names, of which the English is no doubt a corruption;—thus, in German, Isinglass is called *Hausenblase,* from *hausen,* the great sturgeon, and *blase* a bladder. It is exported in the largest quantities from the rivers of Russia, principally from those which flow into the Black and Caspian Seas, but also from the Sea of Aral and the Lake Baikal. The fishery affords employment to numerous individuals, and is still further important from the fish, both in their fresh and in their dried state, forming a great portion of the food of the inhabitants of Russia. Some, moreover, are exported, the eggs converted into Caviare, and the sounds or swimming bladders into Isinglass.

The preparation and commerce of Isinglass are not of recent origin. It is, indeed, remarkable for having been well known at the time of the Romans, and probably at even still earlier periods. For we learn from Pliny, as translated by Holland, " A fish there is named Icthyocolla, which hath a glewish skin, and the very glue that is made thereof is likewise called Icthyocolla (that is fish-glue). Some affirm that the said glue, Icthyocolla, is made of the belly and not of the skin of the said fish, like as bull's-glue. This fish-glue is said to be best that is brought out of Pontus,† the same also is white without any veins, strings, or scales, and very quickly melteth or resolveth." In comparing the different passages of this author, as well as referring to the accounts of previous (as Dioscorides) as well as

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* We have been favoured with the proof sheets of a Pamphlet bearing the above title, written under authority at the India House, and the very useful contents of which we place before our readers. Our own observations on the same subject, and which we intended for the present number, we must now reserve for the 10th No.—ED. *Calcutta Journal Natural History.*

† Laudatur Pontica, candida, et carens venis squamisque et quæ celerrime liquescit.—Plinii, lib. 32, cap. xxiv.

of subsequent authors (see Hardouin's Pliny), where the same fish is mentioned, we find it described as being without bones and without scales, but provided with bucklers on its skin; also that its name is Acipenser, and that it is found in the Danube and in the rivers falling into the Euxine. Hence, there can be no doubt that the substance was Isinglass, and that it was obtained from some species of Sturgeon. The continuance of this commerce from ancient times until the present day is a proof of the abundance as well as of the facility of the fishery. It may likewise be taken as an indication of the excellence of this Isinglass, considering that it is a substance prepared from an organ like the sound, so generally found in fishes. The whole quantity exported from Russia is considerable, but we will at present refer only to that which is imported into England. From McCulloch's Commercial Dictionary, we learn that the imports in 1831 and 1832 amounted on an average to 1,984¼ cwt. a year. In the Report of the Committee on the Import duties, we see, that in the year 1839 there were imported 1,860 cwt. with additional 25 cwt. from British possessions. The former yielding a duty of 4,039*l.* and the latter of 19*l.**

Considering the nutritious nature of Isinglass, and the facility it affords in making elegant dishes for the sick and convalescent, as well as its general uses in confectionary and cookery, its employment in clarifying wine, beer, &c., and its utility also in some other of the arts, we should have expected a considerable increase in the importation even from 1831 to 1839. Instead of this, there is, in fact, an actual decrease, though this is only to a small amount. There is no doubt that the very high retail price of the best Isinglass, amounting to 18*s.*, or even higher, per pound, must check its consumption in domestic economy, and necessitate only the inferior kinds being employed in the arts. Perhaps its being principally supplied from the more difficultly accessible parts of Russia may also have some effect. But the consumption limited by these causes is still further diminished by substitutes being found for it, in a constituent of the animal frame, of which it itself is the purest form.

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* Isinglass, the produce of, and imported from, any British possession, pays 15*s.* 10*d.*, but otherwise imported a duty of 2*l.* 7*s.* 6*d.* per cwt.

This is gelatine, which is very abundantly diffused throughout the animal kingdom.

Gelatine is familiarly known to every one in the form of animal jelly, and is found in considerable quantity in different parts of a great variety of animals. It is distinguished from other animal substances, which it may resemble by being soluble in hot, or rather boiling water, and forming a transparent and colourless solution, which on cooling becomes a solid tremulous jelly. This contains so large a proportion of water that it readily reliquifies on being warmed. Albumen, which, when liquid or in solution, may be mistaken for gelatine, is distinguished from it by becoming solid when exposed to heat. This may be witnessed in the boiling of an egg, the white of which consists of albumen, and was of a glairy consistence previous to the application of heat.

Gelatine, when pure, is transparent and nearly colourless, devoid of both taste and smell, easily preserved when in a dry state, but soon putrifying when moist. It is soluble in the different dilute acids as well as in the fixed alkalies, but the compounds formed with the latter, do not form a permanent lather with soap. A characteristic of gelatine is the copious precipitate which is formed from any of its solutions on the addition of tannin, as in the form of a decoction of oak bark, of galls, or of catechu. The precipitate forms a grey ductile mass which smells like tanned leather, with which it is indeed identical in nature.* The extent to which pure gelatine can unite with water, and still become a solid tremulous mass, has been ascertained by the experiments of Dr. Bostock. He found that when water contained no more than $\frac{1}{100}$ of its weight of Isinglass, it still stiffened completely on cooling, and even if it contained only $\frac{1}{150}$, the solution was evidently gelatinous when cold, though it did not become concrete. "One of the most remarkable properties of gelatine is," as Dr. Prout says, "its ready convertibility into a sort of sugar, by a process similar to that by which starch may be so converted."

It has been stated that gelatine is very abundantly diffused through the animal kingdom. Thus, though not contained in any of the

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* Corrosive sublimate does not precipitate gelatine, and therefore serves to distinguish it from albumen, as both are precipitated by galls and oak-bark.

healthy animal fluids, it is obtained in large proportion from skins, most of the white and soft parts of animals, as cartilage, tendon, and membrane; also from bone and horns. It is likewise found in a large proportion in cartilaginous fishes, and forms the natural cement of many shells. From all these gelatine may be extracted by simple boiling in water, with different precautions in regard to cleaning. From bones it may be obtained by the same process, but with the assistance of pressure, and still more easily, if they have been first acted on by muriatic acid, to remove the phosphate of lime. The obtaining of gelatine may thus give rise to a number of employments, which may be practised wherever these offals are obtainable, and the product, in the form of gelatine, can be turned to account.

The solution of gelatine, which, on cooling, becomes a tremulous mass, may by further evaporation be converted into a hard and brittle substance, well known by the name of glue. This is made from the parings of hides or horns of any kinds, the pelts obtained from furriers, the hoofs and ears of horses, oxen, calves, sheep, &c. In France it is made from the raspings and trimmings of ivory, the refuse pieces and shavings left by button-mould makers, and from other kinds of hard bone. Size, again, is made by boiling down in water the clippings of parchment, glove-leather, fish-skin, and other kinds of skin and membrane. This is used either alone or mixed with flour paste, gum arabic, or tragacanth, and employed by bookbinders, paper-hangers, and painters in distemper.

Mr. Hatchett, many years since ascertained that the viscidity and tenacity of the varieties of gelatine are qualities inherent in each, depending in one, on the age of the animal, the old giving a much stronger glue than the young; in another, on the substances by which it is furnished, as glue obtained from the skin is much stronger than the solid gelatine from bones, sinews, or any other part. Mr. H. further found the force of adhesion of the glue from skin was generally proportionate to the toughness of the skin, those which were soft and flexible yielding a thinner gelatine than the hard bony skins, at the same time that they yielded it more easily.

Considering the nature and sources of Gelatine, and the high price of Isinglass, it is not surprising that the former should be frequently substituted for the latter. Hence we have different kinds of British gelatine and French gelatine, as well as a Patent gelatine, selling at retail prices of from 8*s*. to 12*s*., when the best Isinglass is selling for 18*s*. a pound.

Gelatine is one of the principal constituents of most of the animal substances employed as food, and it is arranged by Dr. Prout among the albuminous group, all of which, he says, "differ from the oleaginous and the saccharine principles in this respect: that they contain a fourth elementary principle namely azote." It forms one of the constituents of bone, from which it may be separated even ages after the animal has ceased to exist, as in the case of the bones of the Mammoth, from which gelatine was separated and tasted at the table of the Prefet of Strasbourg. As it is found in other refuse animal matter, it has been proposed and employed especially in hospitals and prisons, and some public institutions in France as an article of diet in the form of soups, &c., which has by some been disparagingly called "soup of gaiter buttons."

In some recent experiments, it has been attempted to prove that gelatine or animal jelly affords no nutriment, or not sufficient to support the life of the more highly developed animals. Similar experiments have formerly been made with other articles of diet, such as sugar and gum, and now with Gelatine, Albumen, Fibrine, and Fecula, and all with the same results, so as to prove that none of them singly are calculated to afford nourishment and support life. For, in fact, man was not intended to live upon any one of these substances alone, but upon a mixed diet. So Flesh, Bones, and Gluten, being compound bodies, supported life perfectly. Dr. Prout arranges all nourishing substances, capable as they are of assuming an infinite variety of forms, under the three heads, or staminal principles, of the Saccharine, the Oleaginous, and the Albuminous group.* And says as all the more perfect organized beings feed on others that are organised beings, their food must necessarily consist of one or more of the above three staminal principles. Hence, the diet of the higher classes of animals and of man, to be complete, must

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* Gelatine he considers as the least perfect kind of albuminous matter existing in animal bodies.

contain more or less of the three staminal principles, and therefore Gelatine may be one of them.

Isinglass, as already stated, is one of the purest forms of animal jelly, and is brought to market in different forms, sometimes in that of simple plates, at other times rolled up in different shapes, or cut into fine threads. When of good quality, Isinglass is of a whitish colour, thin and semi-transparent, but tough and flexible, destitute of taste as well as of smell. The inferior kinds are thicker, yellowish coloured, opaque, and sometimes having a fishy smell and taste. When placed in cold water, it becomes soft, then swells, and if held up to the light in this state is opalescent. In boiling water, Isinglass is entirely dissolved, with the exception of a very minute proportion of impurities, which Mr. Hatchett ascertained did not amount to more that 1.5 parts in 500; these consisted of earthy residue, which appeared to be the phosphates of soda and of lime. A solution of one part of Isinglass in 100 of water when cooled down assumes the form of a clear and colourless jelly; which is a compound of pure gelatine and water. Though the best Isinglass is thus completely dissolved in hot water; yet much of that found in commerce does not become so, in consequence of the presence of albuminous parts.

With respect to the action of acids and alkalies, as well as of tannin and other chemical re-agents, the effects are the same as those produced on a solution of gelatine.

Isinglass, being mild and unirritating in its nature, and at the same time nutritious, is much employed as an article of diet for the sick and convalescent, and the fine shreds into which it is cut and kept in shops, give great facilities for making a jelly in the shortest possible time. This can be made as palatable and nourishing as any by the addition of sugar and milk, acids or spice; about one-third or half an ounce is sufficient for a pint of water. It may also be taken in the form of a soup with the addition of salt, spices, and sweet herbs, or it may be employed medicinally as an emollient and demulcent, either externally or internally. The best kinds of Isinglass are alone employed in articles of diet and for the best confectionary, being added in small quantities to other, especially vegetable, jellies, to give them a tremulous appearance. But gelatine is now frequently substituted.

Isinglass is also employed in making court-plaster, which, in France, is called *sparadrap d'Angleterre ;* it is a thin coating of Isinglass with a little tincture of benzoin spread on black sarcenet. It is also employed for giving a lustre to some kinds of woven fabric; but it is more extensively used for clarifying different liquors, such as wine, beer, and coffee, than for any other purpose. The inferior kind, called cake Isinglass, being brownish coloured, and having an unpleasant odour, is only employed in the arts, and for the purposes of glue.

The great consumption of Isinglass—necessarily however of the inferior kinds—is chiefly by the brewer, in the process of fining. This he effects by the use of Isinglass, which he dissolves in sour beer to the consistence of thick mucilage. A little of the solution being added to the liquor to be clarified, causes the subsidence of all the suspended matter in the course of a few hours, when the liquor remains perfectly transparent. The sounds of codfish are said to be employed for the same purpose, though I cannot learn that many are imported, except in a salted state, for food. The white of egg, and the serum of blood will also produce the same effect as far as transparency is concerned. The mode of action of these substances in this process is usually explained by supposing that the floating particles become entangled within the Isinglass, as in the meshes of a net, and, uniting with it, form insoluble compounds, which precipitating, are carried downwards, and thus leave the supernatant liquor free from all impurity. Mr. Donovan explains this process by supposing that the substance added, by dissolving in the water, lessens its affinity for the suspended particles, which thus set free, subside by their own specific gravity.

Such being the uses of Isinglass, and its consumption being no doubt limited by its high price, it is desirable to examine more minutely into the present sources of supply, and to inquire whether efficient substitutes, in the form of new varieties of Isinglass, may not be obtained from other parts of the world.

It has been mentioned that Isinglass is chiefly obtained from the rivers of Russia, which fall into the Black and Caspian Seas, and that it is principally formed of the swimming bladders of fishes of the genus Acipenser, or Sturgeon. These belong to the great subdivision of cartilaginous fishes, which are so named from the skeletons being devoid of bony fibres, and chiefly composed of cartilage, with the little calcareous matter deposited in small grains. Among these along with the Sturgeons, are arranged the Shark, Ray, and Skate, as well as the Lamprey and the Myxine, the most imperfect of fishes, and indeed of vertebral animals.

The Sturgeons are easily distinguished by having bony bucklers implanted in longitudinal rows on their skin, and by having their heads, to use Cuvier's expression, similarly cuirassed. The mouth is small, devoid of teeth, and placed under the muzzle. They resemble ordinary fish by having their gills free, which have but a single orifice, and by being oviparous. Internally, they are characterised by having a large swimming bladder, which communicates by a wide hole with the œsophagus. They ascend several rivers in great numbers from different seas, and thus give rise to very profitable fisheries, as their flesh is in some countries esteemed as food, both in a fresh and salted state, while their eggs form Caviare, and their sounds Isinglass.

As the genus Acipenser is known to consist of several species, it might be expected that Isinglass is yielded by more than one of them. This is found to be the case with several, though all the species of the genus have not yet been accurately determined. A few have been known from early times; several were determined by Pallas, no less than nine are figured and described in the Medical Zoology of Brandt and Ratzeburg.*

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* Medizinische Zoologie von J. F. Brandt und J. T. C. Ratzeburg. Berlin, 1829.

The following are the species which are best known, in consequence of their being caught and valued for their products:—

The Common Sturgeon (Acipenser Sturio)—Br. and R. tab. iii. fig. 1,—which is usually about six or seven feet in length, and is found in the Atlantic Ocean, on the coasts of France and of England, in the North Sea, Baltic, and German Ocean, whence it ascends the rivers of France and Germany. It is occasionally caught in the Thames, and used formerly to be considered a royal fish, and much prized, probably on account of its rarity. The flesh, somewhat resembling veal is eaten both in a fresh and salted state. The roes yield an excellent Caviare, the swimming-bladders may yield Isinglass, but are not applied to any use, probably because too few are obtained at a time.

Fishing occupies a great number of people, affords food to many of the inhabitants, and is the source of considerable revenue to

The great Sturgeon *(Acipenser Huso)*—Br. and R. tab. i. fig. 1.—Suppl. tab. i. fig. 1,—called *hausen* or *husen* by the Germans, and *beluga* by the Russians, attains a great size, being often twenty feet in length. It is an inhabitant of the Caspian, especially of the quieter bays and gulfs, and of the rivers which flow into it, and of their tributaries. It ascends these great rivers from the sea, towards the end of winter when they are frozen, in order to deposit its spawn in spring, and is said to return to the sea in the autumn. The fishery is performed by contract. Many of the fish caught are kept in pieces of water, and are again brought up in winter through holes made in the ice. Then the mass of the fish becomes frozen, when it is distributed in this, as well as in a salted and pickled state, through the interior of Russia. The roe and the Isinglass are at the same time separated. A single fish is said sometimes to yield as much as 120 pounds of roe, with which caviare is prepared. This is principally consumed in Russia, Germany, Italy, and by the Greeks during their long fasts: but lately the consumption has much increased in England; that made by the Cossacks of the Oural is usually preferred. The belugas also afford a considerable portion of oil, and the whole fish yields a considerable revenue to Russia. About seven poods and a-half of Isinglass are obtained from 1,000 fish. The roe, or caviare, of 1,000 fish weighs 100 pood, or 4,000 pounds. This species, according to Dr. Martius, yields Leaf Isinglass of three qualities—fine firsts, firsts, and seconds.

The Osseter (A. Guldenstadtii, Br. and R. tab. iii. fig. 2). This species is widely diffused, being found in the Black and Caspian Seas and the rivers which flow into them, as well as in their tributaries; also in Lake Baikal. It yields about one-fourth of all the Caviare and Isinglass of commerce. The caviare is one of the best kinds, and is preferred to that of the belugas. It is probably this species which is called the Sturgeon in the above situations. One thousand, produce two poods and a half of the best Isinglass, and the same number of fish not more than 60 poods of caviare or roe. Both staple and leaf Isinglass are yielded by this species. The varieties of the former are Patriarch, Astrachan, and Astrachan firsts, seconds, and thirds, also leaf and book at Sallian (Martius).

The Sterlet (A. Ruthenus)—Br. and R. tab. ii. fig. 2,—is also very generally diffused, being found in the Caspian and Black Seas, as well as in the Arctic Ocean, in many of the rivers which flow into them, and also in the tributaries; likewise in Lake Baikal. It was transferred by Frederick the Great to the Lakes of Pomerania and by Frederick the First of Sweden into the Malar and Hamarby Lakes. Its flesh is prized. It yields the best Isinglass, especially for inlaid works. In commercial language, leaf and book (first and second). also staple Isinglass are yielded by this species, and its roe yields caviare.

The Sevruga or Sewrjugha, Starred Sturgeon (A. stellatus, Pallas)—Br. and R. tab. iii. fig. 3,—is a native of the Caspian and Black Seas and of their tributary rivers, also of the Lake of Aral. One thousand sevrugas produce one pood and a quarter of superior Leaf Isinglass, and sixty poods of the best caviare.

Russia. Those of the Volga are particularly productive, and consist of the Carp, the Pike, the Trout, the Herring, and of the Pilchard; but to a still greater extent of the Sturgeon, Beluga, and Salmon, besides of the Lampreys and Mackerel in the Crimea for pickling.

M. Schnitzler says, that the Sturgeon fishery is of considerable value: 1,850,500 caught in the year 1793, in the Volga, near Astrakhan, yielded 124,970 poods of caviare and 3,375 poods of Isinglass. The net value of the Russian fisheries is calculated by him to amount to more than 10,000,000 rubles.

The following statement of the produce of the Russian fisheries of the Caspian and its tributary streams, in 1828 and 1829, is extracted from the official Report made to the Minister of Commerce at St. Petersburgh.

Year.	Number of Persons employed in fishing.	Sturgeon.	Sevruga.	Beluga.	Caviare.	Fish Cartilage.	Isinglass.
					Poods. lb.	Poods. lb.	Poods. lb.
1828	8887	43,035	653,164	23,069	34,860 1	1,207 38	1,225 27
1829	8760	68,325	697,716	20,391	28,420 7	1,173 26½	1,092 22

Pallas, in his Travels in the Southern Provinces of the Russian Empire, states that the emoluments of the fisheries in the Volga and the not less productive shores of the Caspian Sea, may be considered as the principal support of the inhabitants of Astrakhan. It would be difficult to find in the whole world, except on the banks of Newfoundland, a more productive fishery, or one more advantageous to the government, than those on the Volga and the Caspian Sea united. During the fasts of the Greek church and the weekly fast days, which together amount to at least one-third of the year, this fishery affords the principal food to the whole European part of Russia, and its populous capitals. Many thousands of indi-

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The other species figured in the same work are Acipenser brevirostris. tab. i. fig. 2. A. Schypa, tab. i. fig. 3, and Suppl. tab. i. fig. 2. A. Ratzeburgii, tab. i. fig. 3. A. Lichtensteinii, tab. ii. fig. 1. With A. Maculosus and Oxyrhynchus of North America described, but not figured.

viduals are employed, and acquire wealth either by fishing and conveying the fish on rafts or sledges, or by selling them in the markets.

The whole value of the Sturgeons of different kinds caught in the waters of Astrakhan and the Caspian Sea, amounts to the annual sum of 1,760,405 rubles.* To this must be added the value of the Persian fishery at Sallian, which, when established only a few years, yielded annually upwards of 300,000 rubles. " It might be still more lucrative, if the injudicious fishermen would preserve the great number of fish, instead of throwing them into the sea as useless, after having collected their roes and air-bladders.

" The most valuable production of the Sturgeons," Pallas continues, " is the Isinglass prepared from their air-bladders. According to the list of exports printed by the English factory at St. Petersburg, there has been exported in British vessels, from 1753 to 1786, from 2,000 to 3,000 ; in later years usually upwards of 4,000, and in 1788, even 6,850 poods of that article. The exportation to other countries has also amounted, within these few years, to above 1,000 poods. The large and almost incredible demand, has, at the same time, tended to increase the price of the different qualities of this commodity at Astrakhan itself ; and on the exchange of St. Petersburg, whence Isinglass of the best quality, so late as the year 1778, did not exceed the price of 36 rubles a pood, it has lately been advanced to 90 rubles."

Isinglass being prepared from the swimming-bladder of certain fishes, and this being an organ generally, though not universally, diffused through that class of the animal kingdom, it seems remarkable that it should not be more generally employed for the purpose of yielding so valuable a commercial article. The fact, however, is, that though Isinglass of the finest quality, and in the largest quantities is yielded by, it is not confined to, the Sturgeon tribe, for even in Russia the *Silurus Glanis*, *Cyprini*, and Barbel yield it, and we meet in commerce with Brazilian, New York, and Hudson's Bay Isinglass.

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* Products of the fisheries of the great Sturgeon amount to	341,535
Little Sturgeon	497,545
Sevrugas	921,325

The fishes which produce it on the coast of Brazil have not been ascertained. Camera supposed it to be a species of Gadus.* Mr. Yarrell informs me that no species of Gadus is caught on the coast of Brazil. The common Cod prefers water of a low temperature; though found all the year about Boston, it migrates northward from New York when warm weather begins. The fishes producing Isinglass in Brazil, he further writes, are probably species of the genera Pymelodus and Silurus, or closely allied genera.

The Brazilian Isinglass is imported from Para and Maranham. It is very inferior in quality for domestic purposes to the best imported from Russia, which sells for 12*s.* per lb., and the other from about 3*s.* to 3*s.* 6*d.*, and even as low as 9*d.* per lb. It is in the form of Pipe, Block, Purse, Honey-comb, Cake, and Tongue Isinglass, the last formed of a double swimming-bladder. The specimens known to Mr. Yarrall appeared to him to belong to different species of Fish.

The Isinglass obtained from North America, in the form of long ribbons, is produced, according to Dr. Mitchill, by *Labrus squeateague,* at New York, which is called weak fish, about fifteen inches in length, and above six pounds in weight, forming one of their most abundant fish, and the principal supply of their tables. One author states that the thick silvery swimming-bladders are pressed, and others that the intestines are cut into strips, and I am told, pressed between iron rollers to form Isinglass.

The Labrus Squeateague is Otolithus regalis of Cuvier (the Johnius regalis of Bloch), of the tribe Sciænoides. These are allied to the Perches, but have more variety, and a more complicated structure in their natatory bladders; almost all good for eating, and many are of superior flavour. To the genus Otolithus also belong some Indian fishes, as *O. ruber,* Cuv., the Peche pierre of Pondicherry, called there *panan,* is fifteen inches long, and is caught in abundance all the year, being esteemed as food, and *O. versicolor,* Cuv. This genus is closely allied to Sciæna, of which species as *S. Aquila (maigre* of the French, and *umbrina* of the Romans), &c., are found in the Mediterranean. S. Pama or Bole Pama of the Ganges resembles the maigres,

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* Notice sur l'icthycolle fonrnée par differentes espéces de gadus que l'on péche au Brésil. La Médicine éclairée par les Sciences Physiques, i. p. 364.

but has a singular natatory bladder. When twelve or fifteen inches long, it is erroneously called *whiting* at Calcutta, and furnishes a light and salubrious diet. It is caught in great abundance at the mouths of the Ganges, but never ascends higher than the tide.

In New England, the intestines of the common Cod (Morrhua vulgaris) are cut into ribbon Isinglass: in Iceland also the Cod is said to yield Isinglass, so also the Ling (Lota Molva). Mr. Yarrell informs me that he has no reason to believe that Isinglass is so prepared, at least in the southern parts of this country; the fish being brought alive in well-boats as far as possible. Cod sounds as used in this country, are mostly preserved soft by salting, and are dressed for table as a substitute for fish.

Hence we see that Isinglass is not confined to the rivers of Russia, nor to the tribe of Sturgeons, but that it is found in fishes on the warm coast of Brazil and the cold one of Iceland. It would not, therefore, be surprising to find it yielded by some of the great variety and shoals of fishes, on the long extended coasts of the British Empire in India. Some experimental quantities have, in fact, already been imported from Bengal into this country within the last year. Indeed, from the accounts published, and the additional facts which will be adduced, it will appear that a trade in Isinglass, and in some of its substitutes, has long been established on the coasts of India.

The first who appears to have drawn attention to this subject, was an anonymous correspondent in Parbury's *Oriental Herald* in January, 1839, who stated, that the Chinese had long been engaged in a trade with Calcutta in Isinglass. Also, that this was afforded by a fish called *sulleah* in Bengal, and that from half a pound to three-quarters of a pound was obtained from each fish.

In consequence of this notice, the attention of Mr. McClelland, of the Bengal Medical Service, was turned to the subject, and he has pursued it with a degree of energy and intelligence, which renders it extremely probable, that Isinglass may be regularly established as an article of export from Bengal to Europe.

Mr. McClelland's first paper was published at Calcutta in June, 1839, in the Journal of the Asiatic Society, vol. viii. p. 203. In this he informs us, that having procured a specimen from the bazar, of the fish yielding the Isinglass, he was surprised to find it to be a species of Polynemus, or paradise fish, of which several species are known for their excellence as articles of food. Of these he adduces the Mango Fish, or Tupsee Mutchee of the Bengalese (*Polynemus Risua,* Buch.) as a familiar instance, though this is remarkable as being without a swimming-bladder :* while the other species have it large and stout. These occur in the seas of warm climates; five are described by Dr. Buchanan in his Gangetic fishes, but only two are of considerable size, occurring in the estuary of the Hoogly, and probably in those of the Ganges. One of these, with another large species is also described by Dr. Russell in his work on the fishes of the Madras Coast. That figured in tab. 184, and called *magaboshee* is *Polynemus uronemus* of Cuvier, while the *maga-jellee,* tab. 183, named *P. tetradactylus,* by Shaw, is probably P. Teria of Buchanan. Both, but especially the first, Russell says, are esteemed for the table, and called *row ball* by the English.

Mr. McClelland ascertained that the species affording the Isinglass, is the *Ploynemus Sele* of Buchanan, *sele* or *sulea* of the Bengalese, described but not figured in his work on the Gangetic fishes (p. 226). Mr. M. has, however, published in the Journal of the Asiatic Society of Bengal, a figure from Dr. Buchanan's unpublished collection of drawings, which are kept at the East-India Company's Botanic Garden at Calcutta. This figure, he states, conveys an excellent representation, about half the size of a specimen, from which he obtained sixty-six grains of Isinglass. Dr. Buchanan describes the Sele as affording a light nourishing food, like most of the fishes which he has called *bola,* but as inferior to many of them in flavour. It is common in the estuaries of the Ganges, and is often found weighing from twenty to twenty-four pounds ;† and may perhaps be the *Emoi* of Otaheiti, the *Polynemus lineatus* of La Cepede, the *P. plebeius* of Broussonet.‡ This, according to Bloch, is by the English

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[*] We have since found this to be likewise the case with *Polynemus quadrifilis, Cuv.*—Ed.

[†] Its ordinary size when in season is from 3 to 4 feet in length, and from 50 to 100 lbs.—Ed.

[‡] The *Polynemus Emoi, P. lineatus, Polynemus plebeius, Polynemus sele* of authors, are different names for one and the same species, called Suleah by the

called king-fish, and is the *Kala mine* of John from Tranquebar, and abundant in the Kistnah and Godavery. Buchanan further states, that the Sele has a strong resemblance to the above named *magabooshee* of Dr. Russell.

As the anonymous author above referred to, states, that from half a pound to three-quarters of a pound may be obtained from each fish; Mr. McClelland supposes either that *P. Sele* attains a much larger size than twenty-four pounds, the limit given to it by Buchanan, or that Isinglass is also afforded by a far larger species, namely *P. tetradactylus, Terea,* or *teria bhangan.* This, as we have seen, is identical with the *maga-jellee* of the Coromandel Coast, and which Buchanan often saw six feet long in the Calcutta bazar, and was informed it sometimes equalled 320 pounds avoirdupois in weight. It is considered by the natives as a wholesome diet, although seldom used by Europeans.

Mr. McClelland says, he has frequently seen them of a uniform size, that must have weighed from fifty to a hundred pounds at least, loading whole cavalcades of hackeries (carts) on their way to the Calcutta bazar during the cold season. Both the Sele and the *teria bhangan* must consequently be very common there from November to March.

Whether both species have natatory bladders was doubtful when Mr. M. wrote his paper.* But from the large quantities and size of the Isinglass which has been produced in the Bay of Bengal, it is probable that it is yielded by both the above species. *P. Sele* is supposed to be a variety of *P. lineatus,* which is said to be common on all the shores to the eastward; but if so, Mr. M. says, it seems strange that the Chinese should send for it to the Hoogly. The same might, however, be said of the Cod, which, though caught in abundance on the coasts of Great Britain, is also diligently sought for on the banks of Newfoundland. He also inquires whether

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Bengalese, and which is well known all round the coasts of India by various local names.—Ed.

* We have since ascertained that of the various species of Polynemus, the *Suleah* alone affords Isinglass, as well as the principal supplies of the article known in commerce as Cod Sounds, or Fish Maws.—Ed.

Polynemus Emoi and P. plebeius, supposed by Buchanan to correspond with his Sele, contain the same valuable substance ? and do either of Russell's species, the above named *maga-booshee* and *maga-jellee* (Indian Fishes, 183-184) yield it ? These questions are very interesting, in connection with the information which will be afterwards given, respecting the extent of the fishery along the coasts of India, and of the export to China of large quantities of a substance which is no doubt one form of Isinglass.

Dr. Cantor, in a paper read before the Royal Asiatic Society, on some Indian fishes found in the Bay of Bengal, says, " To the genus Polynemus, I shall add a species called by the natives *salliah* or *saccolih.* It enters the mouths of the Ganges in shoals, and is equally sought by Europeans and natives for its excellent flavour, which much approaches that of salmon. I have seen it from three to four feet in length and eight to ten inches in depth. It appears equally plentiful all the year round, which is also the case with a nearly allied species, the *Polynemus quadrifilis* of Cuvier." In reference to this passage, Mr. M. says, " I am not sure that the species of Polynemus, Dr. Cantor particularly refers to in his paper as *salliah* or *saccolih,* is not the very fish that affords Isinglass ; if so, it appears to be considered by Dr. Cantor as a new species."*

In his letter, dated 17th February, 1841, Mr. McClelland says, " that besides the Polynemus Sele, the fishes described by Dr. Buchanan, under the name of Bola, all afford a considerable quantity of Isinglass.† Some of the specimens sent are from a species of this genus. Several of the Siluridæ also afford it in large quantities, especially the species marked Silurus raita by Dr. Buchanan." This

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* We have now reason to think the species in question is the Suleah to which so many names have already been applied by different authors.—Ed.

† The Bolæ of Buchanan are the *Scienoides* of Cuvier, one of which inhabiting the coasts of North America, is said to afford Isinglass. Another which we have recently received from Dr. Heddle of Bombay, where it is called *Gol,* and with Polynemus sele contributes to the supply of fish-maws exported from that coast ; we are not yet sure of the species, but we think it has been indicated by Buchanan as a variety of his Bola chaptis, called *Nuria* in Jessore. The same species also exists on the Tenasserim coast, from whence we received a

is interesting and important, as it is probable, as before stated, that a *Silurus* yields a Brazilian Isinglass ; and, *Silurus Glanis*, in the South of Russia, and of several kinds as, firsts, seconds, book, &c., one of which is esteemed in England, it might, therefore, be produced of as good quality by the Indian species of *Silurus*.

The first sample received at the India House was sent to the author by Mr. Cantor, of the house of Cantor and Co., of Calcutta, with a note, dated 30th October, 1840, stating that it was a specimen of a consignment sent by his house in Calcutta.*

The next samples were forwarded by Mr. Rogers to Mr. Melville, the Secretary of the East India Company, for the Court of Directors, with a note stating that they were curious as being the first importations of Isinglass from India. No. 1, was valued at 4*s*., and No. 2.† at 1*s*. 8*d*. per lb., also that the importation from Bengal was expected to exceed fifty tons during the year.

This note was accompanied by a memorandum from Mr. G. Remfrey, stating that No. 1.‡ was Isinglass simply taken out of the fish and dried by exposure to the sun ; and that No. 2. was the same substance partially prepared, by being cut open, the interior membranes taken out, washed with cold water, and beat on a piece of wood ; by which means it is flattened, extended, and loses weight. He further states, that another description of Isinglass is common at Calcutta. This is prepared by the natives to imitate, and is sold for local consumption for one-fourth of the price of European Isinglass. They take the above Isinglass, when in its freshest state, and pull it into shreds with their fingers, then dry it in the sun, and mix with it a small portions of chunam (powdered lime) to preserve it from insects, damp, &c.

Mr. Remfrey also adverts to the fact, that while Europeans were unacquainted with the existence of this trade, the Chinese had from

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specimen for which we were indebted to Mr. E. O'Reily and Mr. Blundell. Both the Tenasserim and the Bombay specimens, were too much decayed to allow of a sufficiently accurate examination, but the species is probably undescribed.—Ed.

* On the part of a constituent.—Ed.

† ‡ These numbers do not eem to refer to the same specimens.

time immemorial been supplied with Isinglass from Bengal. He says, that when in Calcutta he was informed that the natives of the eastern countries were in the habit of coming through the Sunderbuns to a large village, near the salt-water lake, six miles south-east of Calcutta. There they obtain as much as 800 to 900 maunds of this Isinglass for the China market, and pay for it 25 to 40 rupees per maund. The Chinese, it is surmised, use it for their soups, glues, &c. It is imported in the same state as specimen No. 1. It was at this village that both the samples sent were purchased. The Chinese are said also, in one account, to bring back to Calcutta the Isinglass which they had exported from its neighbourhood, but in an improved form, and at a considerable advance of price.

Isinglass, the produce of Bengal, though apparently unknown to the merchants and European residents of Calcutta, has been celebrated in China from the earliest times. Dr. Lumqua, a Chinese physician, long resident in Calcutta, informed Mr. McClelland that the Bengal *Fish-sago* (as Indian Isinglass is called in China), is well known throughout the empire. Also that nothing could surpass his surprise, on his arrival nearly twenty-five years since in Calcutta, when he found that, with the exception of his countrymen, who carried on the trade, no one appeared to know or care anything whatever for the article in question.

The next quantity received, was forwarded by the Governor-General, the Earl of Auckland, to the Court of Directors, as samples of an article of considerable interest; in order that the Court might, if they saw fit, obtain the opinion of competent persons, as to the purposes and probable extent to which Bengal Isinglass of the description sent could be applied.

These samples had been prepared by Mr. McClelland, who forwarded forty-six seers of Bengal Isinglass, in different forms, obtained chiefly from the Polynemus Sele, with other specimens from the species of Bola already alluded to. He states that his attention had for two years been directed to the subject to ascertain the extent to which Isinglass may be procured, and the means by which its manufacture may be improved.

Mr. McClelland also informs us, that in order to ascertain the value of the article, (merely stripped of all impurities calculated to injure its quality, without any regard to appearance), a considerable quantity had been sent to England. An account having been received of the sale, it appears that this Isinglass realised only 1*s.* 7*d.* per lb., which was considerably under its prime cost. Forty-four maunds and ten seers of Fish Sounds having been bought for 40 rupees a maund, required an expense of 100 rupees for cleaning after purchase from the fishermen, thus costing altogether about 1*s.* 1*d.* per lb. This quantity, or 2,235 lbs. at 1*s.* 7*d.* per lb., realised £176. 18*s.* 9*d.*; but the charges in India and in England, consisting of packing, demurrage, freight, insurance, shipping charges, export and import duties, ware-house, brokerage, commission, interest, &c., were so heavy, that the whole did not realise quite one-third of the outlay.

The kinds now sent consist, firstly, of the Isinglass in entire pieces; secondly, of the same cut into fine shreds; and, thirdly, some to which a little chalk had been added, to preserve it dry and free from insects. Also four specimens of Isinglass from the Bola Fish.

These several samples of Bengal Isinglass differ considerably from each other in appearance. Those first received from Messrs. Cantor and Rogers were in oval-shaped pieces, about nine inches in length, and five in breadth, and at least one-quarter of an inch in thickness, opaque, of a brownish colour externally, but beautifully white, even silky-looking, when thin pieces were stripped off.* These specimens had little taste or smell, but as they were only few in number, the smell could not be judged of so well as when in bulk.

Mr. McClelland's specimens vary in length, being from six to twenty-four inches long, about three and four inches broad, and from one-sixth to one-tenth of an inch in thickness.† Whitish in colour, rough in some places apparently from the adhering pieces of membranes stripped off, smooth and translucent in others, and oc-

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* These samples consisted of the Isinglass in its natural state, as taken from the fish, and merely cleaned and dried without any attempt to improve the shape and appearance of the article.—Ed.

† These were stretched and altered in shape, by having been passed between rollers, but in other respects they are the same as the specimens received from Messrs. Cantor and Rogers, and came from the same hands.—Ed.

casionally nearly transparent in some, having something of an oily feel when rubbed, and exhaling a fishy odour when in mass. Some of the specimens are whitish in appearance, from a little adhering chalk, which was sprinkled on the soft substance to assist its drying, and to prevent the masses adhering together. As this is easily brushed off, and is, moreover, insoluble in water, it will not in any way interfere with the article when brought into use.

The Isinglass cut into threads is unsuitable for the English market, notwithstanding that Isinglass for retail is cut into fine threads, as more convenient for general use, and for making jellies and soups, in consequence of the extensive surface which is exposed, rendering it more easily and quickly soluble. But there is a great prejudice in the wholesale market to buying things in a cut or powdered state, in consequence of the innumerable methods adopted, for falsifying and adulterating almost every drug. Machinery is used in London for cutting the Isinglass into threads of any degree of fineness, and as it is impracticable at present to rival this in India, besides having to contend against a prejudice if sent in this state, it is preferable, and will be cheaper, to prepare the article and send it as sheet Isinglass, that is in the form of the slit sounds themselves, or their purest membrane washed, cleaned, and dried in the best manner.

It has been stated that several parcels of Isinglass from Calcutta have already been sent to the London market Though we are not acquainted with the prices which all have brought, yet we have the fullest evidence respecting the cost and the out-turn of one large sample; and that the price was small, compared even with the original outlay. But other parcels have sold at a higher price.

Many circumstances tend to produce an unfavourable effect on the price of an article exposed for sale, independent of the intrinsic value. In the first place, it is new and unknown; this will of itself repel many ordinary purchasers, because they are unacquainted with its peculiarities, and do not consider it worth the trouble and expense of submitting to experiment, more especially as they do not know whether they may meet with it again as a regular article of commerce. Others, again, who are willing to submit it to trial, will only do so, when they can obtain it at a sufficiently cheap rate, and therefore take advantage of its unknown condition to depreciate its value. Besides, there is always a certain degree of trouble and risk with a new substance.

The Indian Isinglass prepared as it is from the sounds of a fish, undoubtedly possesses all the general characteristics of Isinglass, for which reason it is valued by the Chinese, and imported into their country from the mouths of the Ganges. Yet it has some positive defects, which, though interfering but little with its general properties, may give a colour to the objections of purchasers.

That this Bengal Fish Sound does possess the general properties of Isinglass may be proved to the satisfaction of any one who will boil a portion of it for a little time in water. If, after straining, it be set aside to cool, it will be found to congeal into a clear, tasteless, transparent jelly, which, when sweetened and flavoured in the usual manner, can hardly be distinguished from any other kind, as has been observed both by Mr. Yarrell and the author.

Notwithstanding this, some may object to its appearance, as many of the specimens are but imperfectly prepared; but others are fine and transparent enough to be mistaken for specimens of good Russian Book Isinglass. It is not surprising, if without practical experience, and with necessarily imperfect knowledge respecting the best modes of preparing Isinglass on the banks of the Volga, the fishermen on those of the Ganges should not at first succeed in rivalling this anciently established manufacture. Taking all things, however, into consideration, the success of the first attempts is surprising, and assures us how much more is likely to attend the efforts of those who follow Mr. McClelland's example, when informed of the objections made in the London market to their first attempts. This Isinglass, however, appears excellent when compared with the simply dried sounds, or the rude thick masses which characterise Brazilian, which has also the disadvantage of a disagreeable smell, and in portions being insoluble albumen.

The defective preparation of Bengal Isinglass is especially observable in its still retaining something of the fishy smell, as well as in being in part insoluble, apparently from some portion of the albuminous membranes still continuing adherent to the purer gelatinous parts. It is probable, that by increased care in cleaning and drying by exposure to air, some of those defects may be removed, especially as we shall observe, in comparing the two processes, that much greater care is bestowed on the preparation in Russia than in India.

These objections made to the Indian Isinglass in the London Market, and known to many, are embodied in the following letter from experienced Brokers, to whom the author submitted samples of this Isinglass.

TO DR. ROYLE.

SIR,—The three samples of Isinglass are of a quality not unknown to us as from the East Indies, and have hitherto been received in the whole or entire sheet state, and not cut. In consequence of the article not having had sufficient care bestowed upon it before being subjected to the process of drying, so as to remove the unpleasant fishy smell, it is impossible to bring it into use here for culinary purposes, and thereby supersede the Astrachan sorts now in use, and selling at 10*s*. to 12*s*. per ℔. The East Indian will be only available for brewer's use, and then it must be sweeter and of better flavour than the present samples. The Brazil is the description taken by brewers, and is worth 2*s*. 6*d* to 3*s*. 6*d*. per ℔., but is quite free from the objectionable smell, as is also the Samovy, which is of nearly the same value, and applied to similar purposes.

We sold a parcel of East Indian in sheet at public sale in November 1840, at 2*s*. 6*d*. per ℔. in bond, but we think that 3*s*. 6*d*. is nearer the price it would now bring.

THOMAS MERRY AND SON.

15, Laurence Pountney Hill,
26th August, 1841.

P. S. One of the cut samples has been bleached, but is of no more value than the unbleached one.

Mr. Emley, also an experienced Broker, in examining the specimens found some which he considered very well prepared, though the majority were too thick and whitish coloured, instead of being colourless and transparent; Mr. Rogers's specimens he compared to the Cake Brazilian.

Mr. McClelland, in sending this Isinglass, writes, that in Calcutta it was found to correspond precisely with the Russian Isinglass in

Chemical and Essential properties. The author sent specimens to Mr. Hennel of Apothecaries' Hall, which he was good enough to examine. He complains of it as being insoluble, very closely resembling the Brazilian Isinglass, and therefore of low value. As the article promises to be of considerable importance as an export from India, it was desirable to have it submitted to a detailed and careful Chemical analysis. Mr. Edward Solly, jun., Lecturer on Chemistry at the Royal Institution, has furnished the following account of the results of his experiments.

NOTE ON BENGAL ISINGLASS.

Good Isinglass is generally described as being one of the purest forms of Gelatine we are acquainted with; it consists, in fact, of little else besides, and accordingly presents very nearly the characters of that substance. The properties of pure Isinglass or Gelatine are briefly the following. It is transparent and colourless, or nearly so, inodorous, tasteless, and of a hard or horny consistence. It is but little hygrometric, remaining tolerably dry in ordinary conditions of the atmosphere. In cold water, it gradually softens and swells up; in hot water, it easily dissolves, and forms a clear solution, which if it contain as much as a $\frac{1}{100}$th part of its weight of Gelatine, has the property of gelatinizing or assuming the form of a soft tremulous solid as it cools. Dry Gelatine is a permanent and unchangeable substance, but in solution it is very liable to undergo decomposition, becoming mouldy, and rapidly putrifying when exposed to the air; it has been observed that the ordinary and more impure forms of Gelatine are more liable to undergo these changes than the pure substance, the presence of minute quantities of acids, alkalies, and other impurities, greatly accelerating its decomposition. All Isinglass contains small quantities of Albumen, Saline, and earthy matter, and a peculiar substance called Ozmazome, the better sorts containing less, and the inferior more of these impurities.

The Bengal Isinglass consists of Gelatine, Albumen, a small portion of saline and earthy substances, Ozmazome, and a minute trace of an odorous oil. The Albumen exists in an unusually large proportion, which of course somewhat modifies the properties of the Isinglass. The pieces are rather unequal in composition, some of the thinner portions being purer, and containing less Albumen than the others, thus three experiments gave the following results :—

Isinlass.	Soluble Gelatine.	Insoluble Albumen.
1,000 parts	965	35
Ditto	909	91
Ditto	928	72

The best pieces have comparatively little colour or smell, dissolve tolerably easily in water, and form a good firm jelly, which appears to have but little tendency to become mouldy. The inferior pieces are somewhat coloured, unequal in appearance, dissolve with difficulty, and have a peculiar disagreeable smell, in great part due to the presence of the oily substance before-mentioned. From the appearance and properties of this Isinglass, it is probable that its defects are in a great measure to be attributed to a want of sufficient care in its preparation, and it is evident that good Isinglass cannot be made without considerable attention is paid during the processes of washing, beating, scraping, and drying ; all of which have a very important influence on the goodness of the finished Isinglass. Some of the samples of the Bengal Isinglass are unquestionably very good Isinglass, whilst others are decidedly inferior, in consequence of their being but imperfectly soluble in water, and possessed of a peculiar and disagreeable smell; it, therefore, becomes important to inquire into the cause of these objections, and the best way of obviating or removing them. The imperfect solubility of some, and more especially the thick pieces, is occasioned by the presence of a considerable quantity of albumen or insoluble membranous matter, having most of the properties of albumen, which is not only itself insoluble, but in addition renders much of the Gelatine, with which it is associated, likewise insoluble. It is more than probable that the greater part of this albuminous substance might be readily removed by sufficiently scraping the Isinglass during its preparation. Attention should also be directed to the process of drying, as if not properly dried, it might possibly undergo a slight change or decomposition, and become partially converted into a more insoluble form of gelatine. A more important objection is the smell, which, however, may likewise, to some extent, be traced to the preparation. When the inferior pieces of this Isinglass are boiled in water, the surface of the fluid soon becomes covered with a very thin film of oily matter, and the disagreeable fishy odour is then very strong; when, however, the boiling or simmering has continued for some little time, the surface becomes clearer, and the odour gradually diminishes; so that by boiling for some time, good and strong jellies may be easily made, having little, if any, more smell than those made with ordinary Russian Isinglass. Great care should be taken that the Isinglass is as little as possible contaminated with the animal fluids of the fish, because when this is the case it is very difficult completely to purify it by subsequent washing, and a little attention to such points as these would greatly improve the value of the produce. It would be easy to suggest plans for the removal of the bad odour of the Isinglass, but it would be far better if it can possibly be prevented by increased care in the preparation and curing.

E. SOLLY, Jun.
Lecturer on Chemistry at the Royal Institution.

From the foregoing analysis and observations, it is evident that the Bengal possesses all the essential qualities of good Isinglass; and that with a little more care, and some modification in the process of preparation, it is probable that the smell might be got rid of, as well as a considerable portion of the albuminous parts. How these very desirable objects may be best carried into effect, will appear when we can compare the mode of preparing Isinglass in India, with that which has been so long and so successfully practised in Russia.

Mr. McClelland, in the manuscript which accompanied his specimens, states, that the "Sounds when received fresh, are opened and stripped of the vascular covering and internal membrane, washed, and at once made up into any form the manufacturer finds most convenient for packing. The article requires no further preparation than this :—

"When dry, before it reaches the manufacturer, (which is commonly the case, the fish being caught at a distance, towards the sea,) the sound is to be opened, and as much of the lining membrane removed as possible by the hand. A large earthen vessel is then filled with sounds, and water poured into it, and the whole covered up for twelve hours, when the sounds will have been brought back to their original soft state, in which they may be perfectly cleaned, as if they had been obtained fresh.

" For the removal of discoloured parts, as well as for perfectly softening the more solid portions of the Sounds without dissolving the thinner parts, they are steeped a short time in alum water, that is, an ounce of alum in four or five gallons of water. When saturated, each Sound is to be taken out and spread on a linen or cotton cloth, also saturated with alum water, and then rolled tight up and set aside for twelve hours, and this process is to be repeated until the Sound is perfectly bleached, when it may be either drawn out between the fingers into shreds in the direction of the fibre, or rolled into thin plates. When the quantity in hand is large, a little chalk is sprinkled over the soft substance after it has been rolled. This adheres as long as the Isinglass is soft, but may be dusted or rubbed off when it dries. There is, however, no harm in allowing it to remain on the surface, as in case of exposure to damp during the voyage, it may act as a preservative, and it can always be easily rubbed off before use."

If we wish to compare this, with the method of preparing Isinglass on the shores of the Caspian, we shall find that it is difficult to get any account, which is sufficiently minute for a manufacturer to take as a guide, in all the details of the operation. Most of the accounts published are by scientific travellers, and therefore worthy of attention, but the preparation of Isinglass is only one of the numerous subjects which they describe.

The earliest account pretending to any accuracy is that of H. Jackson, published in 1783, in the 63rd vol. of the Philosophical Transactions, who says he made an unsuccessful voyage to Russia to learn the mode of making Isinglass. But he afterwards succeeded in getting the necessary information. His object was to find a good substitute for brewers in fining their beer. For this purpose, he first ascertained experimentally that Isinglass, or the natural membrane of the Sounds of Fish, is much more efficacious than any solution of glue, that is of Gelatine, as it would now be called. He describes the Sounds as taken from the fish while sweet and fresh, slit open, washed from the slimy sordes, divested of a very thin membrane which envelopes the Sound, and then exposed to stiffen in the air. He also details the mode of making, and gives figures of the long and short staple, and of the book form of Isinglass.

The Sounds of the Cod and Ling, he states, bear great analogy to those of the Sturgeons; and that they had been prepared and employed as substitutes for the foreign Isinglass in fining, and with similar effects, except in warm weather. The only peculiarity, he describes in their preparation is, that when the Sounds are slit open, they are washed in lime water, in order to absorb their oily principles; and then in clean water, when they are laid upon nets to dry. He also states, that since this discovery, and before the publication of his paper, forty tons of British Isinglass had been employed; also that several specimens of fine Isinglass had been obtained from North America, in consequence of advertisements distributed in different parts, offering premiums for the Sounds of Sturgeon and other fish. In this we may probably trace the origin of the American trade in Isinglass.

The several distinguished naturalists who were employed by the Russian Government in exploring the different parts of that extensive empire, have collected valuable information on this, as on many other subjects. This we find incorporated in several works, as in Tooke's View of Russia, published in 1799, and in the recent one of Brandt and Ratzeburg (v. p. 17).

Brandt and Ratzeburg describe the swimming-bladder as consisting of three membranes, the outer or peritoneal coat, the middle membranous and muscular one, and the inner glossy highly vascular one, which has a pulpy appearance, and is the membrane which forms the best Isinglass. The species which yield it are the Great Sturgeon, Osseter, Sevruga, and Sterlet, also the *Silurus Glanis*, Barbel, and *Perca luciopenca*, Cyprinus Brama and Carpio, which do not belong to the tribe of Sturgeons.

In the fisheries of the Caspian and Volga, where the system is most complete and the division of labour the greatest, the Sounds and Roes are extracted immediately the fish are caught, and delivered over to the Isinglass and to the Caviare makers. The fresh Sounds are first split open and well washed, to separate the blood and any adhering extraneous matter, (on the Lake Baikal, warm water is used, according to Georgi), they are then spread out, and exposed to the air to dry, with the inner silvery white membrane turned upwards. This, which is nearly pure Gelatine, is carefully stript off, laid in damp clothes (or left in the outer covering), and forcibly kneaded with the hands. It is then taken out of the cloths, dried in the form of Leaf Isinglass, or rolled up, and drawn in a serpentine manner into the form of a heart, horse-shoe or lyre (long and short Staple), between three pegs, on a board covered with them; where they are fixed in their places by wooden skewers. When they are somewhat dried thus, they are hung on lines in the shade till their moisture is entirely dissipated. The oblong pieces are sometimes folded in the form of Book Isinglass. In order to obtain good Isinglass, it is necessary to have well-arranged rooms to dry it in, as at Astrakhan.

It has been questioned by some authors whether any Isinglass is prepared with the aid of heat or of solution, but such will come rather under the head of Gelatine, or of Fish-glue, than of Isinglass. There is no doubt, according to Pallas even, that at the lower parts of the Volga, a fine Gelatine is boiled out of the fresh swimming-bladder, and then poured into all kinds of forms. In Gurief, a fine boiled Fish-glue is prepared, perfectly transparent, having the colour of amber, which is cast into slabs and plates. The Ostiaks also boil their Fish-glue in a kettle. The Common Cake Isinglass is formed of the fragments of the other sorts: these are put into a flat metallic pan, with a very little water, and heated just enough to make the parts cohere like a pancake, when it is dried. The Sounds of *Silurus Glanis* and *Barbel* are pounded and boiled; but, as the glue does not entirely dissolve, the liquid is strained to separate the filaments from the gelatine. Besides these, the cartilaginous and tendinous parts of several fishes are boiled down to form Fish-glue.

The Osseter yields the best kind of Isinglass; that of the Beluga is the worst obtained from the tribe of Sturgeons, but this is said to be improved by the addition of that of the Sevruga and Sterlet. The Glue of the last is the most tenacious, and is valued for inlaid cabinet work. Russian authors state that Isinglass is sometimes adulterated by the intermixture of pieces of common bladder and of the intestines of animals.

In comparing the Russian and Indian processes, we observe a general resemblance, though the differences are considerable enough to modify some of the results. In the first place, the Russian manufacture, being more extensive, has men especially devoted to the preparation of the Isinglass, while others prepare the Caviare, or salt the fish. The inner membrane also of the Sturgeon yields the best Isinglass, while in the Sele it seems to be rejected,* and this would account for the more fibrous nature of the Bengal Isinglass; but it does not follow, that in the Sele, the innermost is the best. A decided improvement would be effected if the Isinglass were prepared as soon as possible after the fish is caught. The Sounds should be extracted, split, and more carefully washed than the native fishermen are likely to practise if left to themselves, besides being freely exposed to the air.

The lightest kind of roof at the nearest point, as at Saugor Island, would probably enable the Sounds to be better dried than when exposed to a powerful sun, as in the latter case the oily parts

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* The structure of the air-vessel cannot be said to be membranous, the inner extraneous membrane which we have said is rejected, is quite different from the air-vessel itself, and consists of a net of blood vessels merely.

The value of the Isinglass appears to depend mainly on the removal of this extraneous membrane, which, as well as a similar outer membrane, may be peeled off when the air-vessel is fresh. If this be done carefully, the Isinglass requires nothing more to render it as pure as it can be. But if these membranes are allowed to remain, or if in removing them, or from any other cause, the little blood vessels of which they are composed be burst or bruised, permanent stains of blood are thus left, which no subsequent washing can remove. The Isinglass being translucent, these stains, however superficial they may be, appear to penetrate the mass (though such is not the case) and are visible on both sides. As the removal of these membranes in the first instance when the fish is caught must be left to the fishermen, from whose carelessness it would be impossible altogether to avoid some stained or discoloured spots, we would therefore recommend the article to be sorted, and such parts as are free from stains and membranes, selected as

Firsts.—This will always be of uniform yellowish white colour, and translucent when held to the light.

Seconds.—This will consist of the discoloured parts removed from the firsts, it will be translucent on the edges of the stains, which will be found to be superficial, affecting only one side.

Thirds.—This would consist of parts of firsts and seconds, from which the membrane has been imperfectly removed.—Ed.

may melt, and be more extensively diffused through the membranous structure, than would be the case in drying in the shade. Part of the oiliness and smell may probably be removed by chemical reagents, as lime and chlorine, but these should be with care, as their use is so likely to leave a taint on the Isinglass, that it would be objected to by manufacturers. Thus some Isinglass is employed for glazing calicoes, and an attempt was made to substitute glue, but it was found that the alum, of which the glue contains a trace, changed the colours of the printed calicoes.

The Indian Isinglass as at present prepared, is complained of as too thick, if intended to come into competition with the superior varieties of Russian Isinglass. Some of it may, without difficulty, be rendered thinner, as even in the dried state, layers of membrane may be stripped off, which display a fibrous structure, and which no doubt contain the greater portion of the insoluble albumen. It might also be made thinner by beating, or pressing between iron rollers or marble slabs, as is done with American and some kinds of Brazilian Isinglass, and then cut by machinery into a fit state even for domestic use. The extra labour which this would require might be profitably saved, by not tearing it into fibres, in which state it is disapproved of in the market. The refuse might be turned to account; the soluble parts of the Sounds separated from the insoluble, and poured out into thin plates and dried on nets, as is done with some of the gelatine of commerce.

By these means, or by others which will no doubt suggest themselves, when the objections to the Indian Isinglass are known, the manufacturers will be able to improve it to the degree requisite to enable it to occupy a permanent, as well as a high place among the Isinglass imported into the principal markets of Europe. Though the first quantities sent from India brought only 1*s*. 7*d*., others have been sold for 3*s*., and a few samples have been valued at 4*s*. per pound. Besides this opening for an extensive sale in the European market, even in the present state we know there is always a constant demand in China for the Isinglass of Bengal. These will no doubt afford sufficient encouragement to persevere in the extension and improvement of this newly-established and highly promising article of the export trade of India to Europe.

Seeing that so large a quantity as 800 or 900 maunds, of the Sounds of Fish, that is of Isinglass, is exported from the neighbourhood of Calcutta, it is certainly remarkable that it should never have attracted the attention of any one even as an object of curiosity. Still more so that it should have escaped the notice of mercantile men, as doubtless a knowledge of the fact, might have been turned to profitable account. But now that it is known, those who are interested in the improvement of the Resources of India, will not feel satisfied with seeing a lucrative trade confined to one place, when there is every probability that it might be profitably practised at many points of the long extended coasts of the British Empire in India.

It becomes desirable, therefore, to ascertain the points where the fishes yielding Isinglass in the Hoogly and the Sunderbuns resort to in shoals, such as at the mouths of the Irrawady and Burrampooter, at those of the Mahanuddy, Godavery, and Cauvery, or in the Gulfs of Cambay and Cutch, and at the mouths of the Indus. Also, whether there are not, in these situations, other fishes of which swimming-bladders are at least as easily convertible into Isinglass. And at the same time to inquire whether Isinglass or any similar substance is at present exported, by the Chinese or others, from these situations.

The fondness of the Chinese for all gelatinous substances is well known, and has been described by all those who have visited their country and partaken of their banquets. In addition to employing, animals and parts of animals which are rejected in other countries, as articles of diet, they import various substances which can be valuable only as yielding gelatine of different degrees of purity; of these we have examples in Agar-Agar, Tripang, Birds'-nests, Shark's-fins, and Fish-maws.

The Agar-Agar is a species of Fucus or Seaweed, exported from the islands of the Indian Archipelago, and is a portion of the cargo of every junk. It forms a gelatinous mass with water, to which the Chinese add sugar, and use as a sweetmeat. Another Sea-weed *(Gracillaria tenax)* is imported in large quantities into Canton from the coasts of Fo-kein and Tchekiang, and is supposed to be an ingredient of the Chin-chou glue or jelly. Another species, a native of Ceylon *(Gracillaria lichenoides)*, is also of a gelatinous nature; and after being washed in fresh water and pressed to remove the salt and some mucilage, it is employed as a preserve. This is thought to be the substance which by some is considered to be a species of gelidium, and by others the spawn of fish floating on the surface of the sea, made use of by the Salangana, or Esculent Swallows, in constructing their nests, which are so highly esteemed by the Chinese. That appears, however, rather to be a viscous secretion of the salivary glands of the mouth and stomach of the bird, which may be observed hanging from its bill. The nests, as Mr. Crawford remarks, both in external appearance and consistence somewhat resemble a fibrous ill-concocted Isinglass. At all events, the best kinds are sold for about *5l.* 18*s.* 1½*d.* per pound, and even as high as 4,200 Spanish Dollars per picul; these last, therefore, are more valuable than their weight in silver. Mr. Crawford calculates that not less than 242,400 lbs. of different qualities (white, black, and ordinary) are yearly imported from the Indian Islands into China.

Mr. Crawford, after stating that the Fisheries of the Indian Islands form a most valuable branch of their industry, and that a great variety of the fish caught are dried in the sun, proceeds to observe that " ordinary dried fish forms no portion of the foreign exports of the Indian Islands, but three singular modifications of it do, ***Fish-maws, Shark-fins,*** and ***Tripang,*** all of which are sent to China in large quantity." The Tripang Swala, or Beche de Mar, often called Sea Slug, one of the tribe of Holothuriæ, is an unseemly-looking molluscous animal, which constitutes, in quantity and value, one of the most considerable articles of the exports of the Indian Islands to China. There are fisheries of Tripang in every country of the Indian Archipelago, from Sumatra to New Guinea, and upwards of not lees than 8,000 cwt. are yearly sent to China from Macassar. The price ranging from 8 Spanish Dollars per picul to 20, and as high as 115, according to the quality. The same author states, that Shark-fins are exported to China from every maritime country, between the Arabian Gulf and the East Indian Islands. A picul of Shark-fins usually sells in China as high as 32 Spanish Dollars, or at 6*l.* 1*s.* per cwt., which high price makes it evident, that they are no more than articles of luxury for the use of the rich. In the market of Macassar, the ordinary price is about 15 Spanish Dollars, or 2*l.* 16*s.* 8½*d.* per cwt.

Of the three substances mentioned by Mr. Crawford as exported from the Indian Islands, one only remains to be noticed, and this is *Fish-maws.* But of this he merely says, that it "is a favourite article of the strange luxury of the inhabitants of that country, often bringing as high as 75 Spanish Dollars per picul, or 14*l.* 3*s.* 6*d.* per cwt., in the market of Canton." Neither in his nor in any of the other works which the author has had an opportunity of consulting, has he been able to find any description of fish-maws. The name had frequently struck him when endeavouring to ascertain the countries which actually produced different drugs, by tracing their names from one price-current into another. Being unacquainted with this substance, and unable to procure information respecting its nature, he placed it in a list of subjects for inquiry.

In the course of the present researches respecting the production of Isinglass in India, the subject recurred to his mind; he then again referred to the price-currents, and finding that fish-maws were imported into Canton and exported from Bombay, he was induced to consult the official accounts of the exports and imports from the three Indian Presidencies. And was surprised, as, no doubt, others will be, to find that no less, than to the value of nearly forty thousand pounds of Shark-fins and Fish-maws was exported in one year from Bombay to China, being first imported from the great variety of places mentioned below, and sold at the following prices:—

The price of Fish-maws was from 90 to 105 rs. per maund in 1836-37
Ditto ditto ditto 92.8 to 95 ditto in 1837-38
Ditto Shark-fins ditto 18 to 25 ditto in 1836-37
Ditto ditto ditto 35 ditto in 1837-38

Quantities and Value of Shark-fins and Fish-maws imported into and exported from Bombay in the years

Shark-fins and Fish-maws.	1836—37.			1837—38.		
	Cwt.	lbs.	Value. Rs.	Cwt.	lbs.	Value, Rs.
From the Coasts of—						
Africa	38	0	1,309	87	66	2,709
Ceylon	5	52	225			
Arabian Gulf.............	915	72	32,775	461	84	14,815
Persian Gulf.............	1,849	0	69,086	2,456	70	80,721
Malabar and Canara.....	417	101	10,874	647	96	14,359
Cutch and Scinde.........	742	91	34,916	0	133¼	512
Goa, Demaun, and Diu,	203	70	15,748	68	63	4,681
Subordinate Ports—						
Panwell and Concan.....	101	93	6,330	183	6	3,726
Guzerat	15	90	580	108	49	4,437
Imports into Bombay.......	4,172	50	1,64,931	4,356	103	1,49,529
Exports to China...........	9.426	28	3,92,676	5,088	39	2,55,541

Besides these there were imported into Madras :—

Shark-fins & Fish-maws.	1837—38.	
	Cwt. lbs.	Value. Rs.
Imports—Fort St. George		
From Ceylon and Tranquebar	64 0	252
From Ganjam, Vizagapatam, Rajahmundry, and along the Coast	105 0	3,814
Fish-maws from Ragahmandry, Tanjore, Timmully, and Malabar.		
Exports—		
To China and Straits of Malacca	1,043 0	22,880
From Tanjore to Straits of Malacca	39 0	11,527

From the quantities of Fish-maws which the author thus unexpectedly discovered, were exported, and the high price which was paid for them, that is from 2*s.* 1¼*d.* to 2*s.* 6¾*d.* a pound, he concluded that the substance must be well known ; or if not the fish, at least the part of the fish which was so called. But on inquiring of several gentlemen well acquainted with the products and commerce of Bombay, he was unable to obtain any more precise information than he had already procured. He then applied to Mr. Malcolmson, of the respected firm of Forbes and Co., to obtain for him the requisite information, and, if possible, a sight of a specimen, if there should be any in London. Mr. Malcolmson was good enough to send him some specimens, of different sizes of the Bombay Fish-maws. On examination, these proved to be composed of a sac-like membrane, which had been slit open ; some were small, thin, and transparent, others three and four inches across in both diameters, something of the shape of short purses with spring clasps, of a light colour, and semi-transparent, and resembling the ordinary qualities of Isinglass, especially some of the Brazilian kinds, in appearance. On submitting these to Mr. Yarrell, he pronounced both kinds to be the Sound of a Fish which he thought might perhaps be the same species, but at different ages, and that it was apparently allied to the Gurnards. It is interesting to observe, Cuvier mentions that there are species allied to *Trigla hirundo* (or the sapphirine Gurnard) in India.

Thus we see that fish-maws are Fish Sounds ; and as Fish Sounds of another Fish were carried away by the Chinese from near to Calcutta, at the rate of about a shilling a pound, without any one being apparently aware of it, so in Bombay a commerce has long been established in Fish-maws, at about double the price of the former, without its being generally known that it was Isinglass which was thus exported. The Chinese, therefore, obtain from India, what we import from Russia and Brazil, and in this respect they exhibit no greater strangeness of taste than we do ourselves. For they give only about the same price (14*l.*) which is obtained in the London market for Isinglass of the same quality, and while we give as much as between 60*l.* and 70*l.* for the best kinds; and between 90*l.* and 100*l.* when we require this for consumption.

The large quantities in which these Fish-maws are collected and exported from the Port of Bombay (independent of what Mr. Crawford mentions as exported from the Indian Islands to India), indicate that very large numbers of Fish must have been caught. In fact, that the natives of these various countries must be in the habit of paying very considerable attention to Fishing in general. We are thus almost insensibly led from a consideration of the mode of preparing the Sounds of Fish, to that of the methods of procuring and preserving the Fish themselves. Also to the amount to which these processes are practised, or to which they may be extended.

The most cursory inspection of the preceding table of the imports into one port, shews that Fishing must be followed to a considerable extent on the African Coasts, and the Gulfs of Arabia and Persia. The Arabs have indeed, from the earliest times, been noted as navigators, and for having been the carriers of the produce of India to the shores of the Red Sea, and the banks of the Euphrates, which thence found their way into Egypt, Syria, and Europe. The Natives of India are generally supposed to be little addicted to the sea, or to availing themseleves of the treasures which it affords, but the foregoing table shews that the Gulfs of Cutch and Cambay, as well as the Malabar and Coromandel Coasts, all send the spoils of the sea to be exchanged for the treasures of the land. We know also that Fishing is practised to a consideration extent in the vicinity of Bombay, Madras, and Calcutta, as well as every where in the rivers, in the interior of India. It may be thought that this change has taken place in modern times, but if this were so, it is curious that in the Institutes of Menu, who is said to have flourished 800 or 900 years before the Christian æra, he should make an exception, in limiting the legal interest of money, in regard to adventurers at sea, and that Fa-hian, in the fifth century, made a voyage from Java to Ceylon in a vessel belonging to Brahmins.

In the present day, Sir A. Burnes represents "the mariner of Cutch as truly adventurous," putting to sea, for a trifling reward, and stretching boldly across the ocean to Arabia, the Red Sea, and the Coast of Zanguebar in Africa. The sea vessels of Curachee sail to Muscat, Bombay, and the Malabar Coast; and the fishing-boats at the mouths of the Indus he describes as good sea-boats, as sailing very quickly, and as numerous, because the fisheries there are extensive, and form a source of commerce. So Dr. Cantor states, that at the mouths of the Ganges the fishermen have sea-going boasts, which they build themselves; and that they are a superior description of Indian Sailors, of much more industrious habits than the majority of the natives of India. If we look still further to the eastward, we shall see the Burmese and Siamese almost living in boats, and the Malays most formidable as Pirates in the India Seas. Mr. Crawford represents the Indian Islanders as expert fishermen, and that there is no art which they carry to such perfection as fishing, which the nature of their climate allows them to practise, with hardly any interruption, from one end of the year to the other, the fishing-boats proceeding to sea with the land-breeze at an early hour of the morning, and returning with the sea-breeze a little after noon. The fisheries afford a most valuable branch of their commerce, as a great variety of their fish are dried in the sun, or salted and dried, and sent by the inhabitants of the Coast in large quantities into the interior of their islands, or transmitted to every part of the Archipelago.

Seeing that the inhabitants of the Coasts of these various countries already practise fishing to some extent, it is desirable to inquire whether it may not be still further extended. Dr. Cantor has particularly called attention to the importance of attending to, and encouraging the sea fishery, in a paper which the author had the honour of presenting to the Royal Asiatic Society, and which is published in their Journal. Sea fishing, Dr. C. states, is carried on to a very small extent, chiefly because the distance to Calcutta is too great to allow of the carriage of fish in a fresh state. The only class of fishermen who have sea-built boats inhabit villages situated near the entrance of the Hoogly. Their chief and most profitable employment consists in attending with their boats on the shipping entering and leaving the river, for which they receive 16 rupees per diem. Whenever this employment fails, they resort to work with their nets, which they drag during high water along the coasts of the Sunderbuns. Two or three times are, generally speaking, sufficient to load a boat with fishes and shell-fish; (a truly prodigious quantity being brought up in a few hauls). The larger portion of the prize which is not consumed or otherwise disposed of on the spot is then preserved. This process consists simply in dividing the fish, taking out the viscera, and spreading them in the sun till they become sufficiently dried.

" With a view to ascertain how far the locality and climate would favour the process of salting and drying fishes on the coasts of Bengal, Captain R. Lloyd, (who as Marine Surveyor General, has always evinced a strong desire to inquire into the natural products and resources of those localities which by his indefatigable zeal have been surveyed), caused a series of experiments to that effect to be tried on board. The materials submitted to trial were either purchased from fishermen at the rate of three rupees a hundred, or supplied by the nets belonging to the fishing-boats attached to the survey. The experiments turned out so satisfactorily, that I feel convinced that the process of curing, salting, and drying fishes, may easily be accomplished there during the north-east monsoon, that is, during the period from 15th October, to the 15th of April." (*Cantor l. c.*)

Dr. Cantor did not fail to take advantage of the opportunities which others neglect, and made himself acquainted with the natural history of the part where he was placed. Thus, while discharging the medical duties on board the Honourable Company's surveying vessels at the Sandheads, he examined the Fishes of the northern part of the Bay of Bengal, and those of the Gangetic estuaries. He observes, that by reference to the ichthyological works of Dr. Russell, Dr. Buchanan, Baron Cuvier, and Mr. Bennet, describing the Fishes from different Indian localities, he found that at least one-third, perhaps one-half, out of upwards of a hundered species, which he examined between Calcutta and the 21° of N. latitude, were not noticed by the above authors. The fact is, as he states, he observed many species, inhabiting a more southern latitude, which were brought up towards the mouths of the Ganges, by the strong flood-tides prevailing during full moon, while others only temporarily enter the rivers during the spawning season.

The Polynemus *Shalliah* or *Saccolih,* has already been mentioned as entering the mouths of the Ganges in shoals. The Kharrah, or Indian Mackerel, a species of Thynnus, is rather uncommon in these estuaries, but it must be found in abundance on the Burmese coast, as from thence, great numbers in a dried state, are annually imported into Bengal. The Cartilaginous fishes, Dr. C. states, abound in numbers and species, and are remarkable for their wide geographical distribution. The sharks enter the rivers to a considerable distance from the sea. Shark-skin, he says, is used by the native workmen for polishing wood and ivory; and Shark-fins we have seen are largely exported to China.

Of the better known salt-water fishes of a wider geographical distribution, such, for instance, as are valued as articles of food, at the three distant points, Calcutta, Madras, and Bombay, the market of the first is the least rich in varieties, in consequence of its greater distance from the sea. The abundance of the supply, however, makes up for what it wants in variety; and the great demand for fish affords a livelihood to great numbers of fishermen, who every night spread their nets in the river, and in the salt-water lake.

The Lates nobilis, different species of Polynemus, and the Mugil Corsula daily cover the tables of Europeans, who will more readily recognise these fishes under the names of the Begti or Cockup, Sudjeh, Tupsi (Mango fish), and the Indian Mullet. At the Sandheads, may be found some of those delicious fishes which are more familiar to the residents of Madras and Bombay; for instance, the Indian Soles, the Roll-fish, and, above all the Black and White

Pomfrets, and the Bummoloh, which latter, in a dried state, is known by the name of the Bombay duck. Of these, the Indian Mullet is the most widely distributed, being common in the Straits of Malacca, the Bay of Bengal, the Persian Gulf, and the Red Sea, also at the Cape of Good Hope.

"The bazars in Calcutta," Dr. Cantor remarks, "are always stocked with an ample supply of dry fish, which is consumed partly by the European and native shipping of that port, partly by the poorer classes of Bengal, and the Upper Provinces. Cargoes of this article are annually imported by the Burmese and the Arabs."

But as no duty is levied on the importation, Dr. C. had been unable to ascertain the actual amount, which, however, from the information he obtained from European and native merchants, he had no doubt was considerable. By examination, he found these dried fishes to consist chiefly of the Bummalos, the above named Siluroid Fish, which sells in Calcutta at the rate of four or five rupees a hundred, the Indian Mullet, the Sudjeh, the Begti, and the Kharrah or Indian Mackerel.

The demand for dried fish exists all along the Coasts of the Peninsula, as the author, by examining the official accounts of the commerce of the different districts of the Presidency of Fort St. George, finds that dried or salted Fish is imported from Bengal, Pondicherry, Ceylon, Travancore, Goa, Bombay, and Arabia, also sometimes from the Maldives into Ganjam, Madras, Tanjore, Tinnivelly, and Canara, as will appear from the following table. Of the quantity imported, a small portion, to the value of 1,009 rupees, was taken into Mysore, and to the value of 1,087 rupees exported to the Straits of Malacca.

Salted and dried Fish, imported into.		*Rupees.*	*From.*
Ganjam	to value of	5,377	Pondicherry, Bombay, Arabia, Ceylon, and Travancore.
Madras	ditto	7,921	
Tanjore	ditto	1,181	Ceylon.
Tinnivelly	ditto	3,512	Travancore and Malabar, by sea.
Ditto	ditto	69,590	Travancore, by land.
Canara	ditto	6,037	Arabia, Bombay, and Pondicherry by sea.
Ditto	ditto	3,625	Goa, by land.

That considerable attention must be paid to fishing all along the coasts is evident from these facts, as well as from those adduced respecting Fish-maws and Shark-fins. At Bombay the large quantities of the Bummalo, which are both consumed and exported, prove the same, though, from no duty being levied, we are unable to ascertain the quantities which are either caught or exported. At the mouths of the Indus, the fishery is extensive, and there, no doubt, some of the Fish Sounds are procured. This is evident from the imports into Bombay, and from Lieutenant Carloss stating, that Cod Sounds and Shark-fins are exported from Curachee. The former are, no doubt, Fish-maws, perhaps Sounds of Polynemi, as Mr. McClelland suggests, but they may also be those of other fish, as the specimens of Fish-maws given to the author by Mr. Malcolmson are very different in form from the Isinglass sent from Bengal.

Mr. McClelland, in his paper, calls attention to the very important subject of increasing the supply of fish in the interior of India. Wherever there are any large pieces of water for the purposes of irrigation, as in the Peninsula of India, these he conceives might support quantities of fish, if proper kinds were selected, and pains taken to destroy the injurious animals, in the season when the water is sufficiently low for the purpose. He also suggests that at the different sanitaria which have been established in the mountains, it would be desirable, and easily practicable, to form vivaria, which would at all times yield a supply of fish. This might, as he suggests, be done by damming up a portion of some of the valleys through which the mountain streams pass.

He also further recommends that the natives of India should be encouraged to turn their attention to the curing of fish in districts where they are abundant, and in sending them to others where they are less so, and for consumption at seasons when fresh fish becomes scarce. "The cold season, from November to February, when most fishes are taken, is short. The fishermen not having the means of curing their fish, have nothing to stimulate them to any exertion, beyond what can be consumed when fresh. Had the fisherman the means of preserving the result of his labours, his chief market would commence when the fishing season ends, and his industry would then become a permanent benefit to himself and the country at large."*

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* Mr. McClelland observes, that it must have been long known, that the difficulty of preserving meat depends more on the state of the atmosphere in regard to electricity and moisture, than on temperature, &c. With salt and other means at hand, he conceives there would be no difficulty in curing fish in an Indian climate in the months of November and December, when the Sullea fishery could be carried on. On this subject, of very considerable interest, Mr. C. K. Robison, one of the magistrates of Calcutta, remarks: "It would be a famous thing if these enormous fish (the Sullea) could be cured, as well as their Isinglass obtained; and I cannot help thinking the measure very feasible, if the fishermen at the time of taking them and cutting them up, dipped them first into weak chloride of soda, mixed with a small quantity of impure pyroligneous acid. This would not only preserve the fish till the salt acted, but improve the flavour." The pyroligneous acid, or a solution of Creosote, would probably produce the desired effect; if Mr. R.'s hint is followed literally, the mixture would produce an acetate of Soda.

An account of the Electro-Magnetic Engine. Translated from the German. By DR. TAYLOR.*—*London* 12*mo.* 1841, *Plate* IV.

By a Vote of the German Diet, the sum of 100,000 florins has been awarded to the Inventor of the Electro-magnetic Engine. The following pages are faithfully translated from the second and improved Edition of the original German Work, of which one thousand copies were sold in the short space of a week. In it will be found a report of the Experiments of Jacobi, Lenz, Davenport, Davidson, Stoehrer, Wagener, &c. with every improvement to the present time.

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* Mighty and vast is the influence which Steam (since the commencement of the present century) has exerted on all the relations, as well of nations as of individuals. It has served to facilitate the intercourse between lands the most distant, and has confessedly exerted an influence on the face of empires, more incalculable in its effects than any previous invention to which the mind of man has given birth. For England, especially, it has served to consolidate the

On the Laws of Electro-Magnetism, and its application as a moving power.

If you immerse two pieces of metal of different kinds—for instance, a piece of copper and a piece of zinc—in an acid diluted with water, or in a weak solution of an alkali or salt, in such a manner that the metals shall not touch when in the fluid, but be connected externally by means of a metallic rod, or wire, an electric current will thereby be produced; which will pass from one piece of metal to the other, by means of the connecting rod, and be conveyed to the former through the agency of the intervening fluid: this electrical current will continue to circulate in this manner, as long as no insuperable obstacle be interposed by the metals or fluid themselves. This electricity is identical with that developed by an electrifying machine, and that with which the thunder-cloud is charged; the only difference being, that the electri-

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varied elements of its power, and by annihilating space and time, brought the geographical parts of the gigantic empire of Britain into such immediate proximity, that it may be said to have diffused new life and vigour throughout all the veins of its giant members, and given a nervous strength to its arm, which must long perpetuate its sway.

Great, however, as have been the benefits which we have thus recorded, we cannot disguise from ourselves the many unavoidable dangers and imperfections with which Steam, as a moving power, has been, and must ever be, attended, arising from the nature of the agent employed, and the extreme costliness and expense attending the consumption of fuel, without taking into consideration the utter impossibility of procuring the necessary supply exactly where it is most needed.

That Steam is about to be superseded, through the manifold advantages of the invention or series of discoveries which will be found detailed in the following pages, can hardly admit of question.

The chief inducement which has led the translator to undertake the rendering of these few pages, was the desire to attract the more general attention of the practical mechanic of England to the consideration of so engrossing a subject; to effect which every effort has been made to divest the translation of technicalities, and render it as universally intelligible as the subject would admit: to the scientific scholar, it may not be uninteresting to be informed of what is being done in other countries in relation to this important subject.

We think it hardly necessary to allude more particularly to the advantages which Electro-magnetism offers, and content ourselves with referring to the results which have been deduced from experiment and practice.—Translator's Preface.

city in the former is in a state of motion, whilst in the latter it is in a state of equilibrium. As it exists in the metals and fluids alluded to, it gives forth a feeble but continuous electric shock. This electrical current has the effect of heating the connecting wire, and imparting to it a magnetic virtue. This species of electricity, developed by the connection of metals with acids, has received the names of galvanic and voltaic, from Galvani and Volta, the original discoverers.*

From the period of the discovery, by Professor Orsted, of Copenhagen, in 1820, of the peculiar influence exerted by the electrical current on the magnetic needle, no possible doubt could be any longer entertained of the connection between magnetism and electricity. And the varied exertions of scientific men of different countries have succeeded in directing attention to a new branch of study, which does not date beyond twenty years ago; the influence of which on practical life promises to become more and more beneficial. To the exertions of Schweiggers we are indebted for the multiplier, or galvanometer; by means of which the relative strength of different currents may be tested. Ampère succeeded in shewing, that a wire, spirally coiled, possesses all the properties of an ordinary magnet, as long as the electrical currents circulate therein. Sturgeon, of Woolwich, was the first who, in 1826, produced a powerful electro-magnet, by coiling wire spirally round a bar of soft iron, and discharging an electrical current through the wire. Henry and Ten-Eyk, in America, have already produced magnets capable of raising two thousand pounds weight, and upwards. It therefore appears, that, whilst it has been hitherto a matter of much difficulty to procure magnets of any considerable power, we need at present nothing more than a bar of soft iron, horse-shoe shaped, round

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* If the electrical current be brought to bear on a fluid, it resolves it into its two principal constituent parts: thus, for instance, water is thereby resolved into oxygen and hydrogen, sulphuric acid into sulphur and oxygen, and *blue vitriol, or vitriol of copper, into sulphuric acid and oxide of copper:* and this separation of the parts is peculiar, in so far as the oxygen, or body most resembling it, invariably attaches to the zinc, whilst the other constituent element attaches itself to the copper; but in the canal between the zinc and copper no trace of this action is visible. On applying blue vitriol diluted with water, the sulphuric acid of the salt and the oxygen of the water will be recognised on the zinc, and the oxide of copper of the former and hydrogen of the latter on the copper. The oxygen and zinc combine, and give oxide of zinc, and this resultant combined with the sulphuric acid yield sulphuretted oxide of zinc; whilst the hydrogen in combination with the oxygen contained in the oxide of copper forms water; and we thus arrive at a clear precipitate of copper. The above-named substances, copper, zinc, water, and blue vitriol are the bodies whose agency is principally employed in the galvano-magnetic machine.

The copper which is thus obtained is perfectly pure, and covers at least one half of the loss of zinc occasioned by the process.—*Algemeine Anzeiger der Deutschen.*

which a wire is coiled, and a pair of proportionably large plates of zinc and copper, connected together by a wire, and separated by an acid diluted with water, to be able to produce magnets capable of bearing several hundred weight; and also of depriving the most powerful magnets in an instant of their magnetic virtue, or of completely reversing their poles. This peculiarity of being able to produce magnets of almost unlimited power, and of again instantaneously reversing their power of attraction and repulsion, led very naturally to the idea of employing these forces as a moving power, as steam or water has been hitherto used.

It being, however, necessary for the judicious and practical application of the electro-magnetic powers, to be acquainted with the general laws which govern them, we shall take the liberty of mentioning the most important of them here.*

The various experiments of the scientific have succeeded in establishing the following results, which we shall record with as much brevity as possible:—

I. As to the influence of the strength of the current on the intensity of the magnetism produced in the iron. Fechner dal Negro and Professor Jacobi have shewn by experiments, that the intensity of the magnetic power produced in soft iron is proportioned to the strength of the current applied.

II. As to the influence of the thickness of the wire of thes pirals employed on the magnetism produced, the experiments of Lenz and others have shewn that the greater or less thickness of the coils employed is wholly immaterial as to their capabilities of magnetizing; but that as the thicker the wire is the greater its conducting power, the thinner wires require stronger electrometers than the thicker ones, in order to produce a current of equal intensity.

III. As to the width of the coils, or the diameter of the spirals, or the distance of the wire from the centre of the iron, it appeared that the magnetism produced by spirals of different widths; but, *cæteris paribus,* was proportional to the strength of the current actually coming into play; and that the trifling difference arising from the greater distance of the coils from the centre of the iron, which was experienced in practice, may be wholly disregarded. So that it might be considered

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* The Translator begs leave to refer such of his readers as desire to become more thoroughly acquainted with the laws here alluded to, to the proceedings of a Meeting of the British Association for the Advancement of Science, held at Glasgow, a correct report of which, as far as relates to this interesting subject, will be found in No. 678 of the *Athenæum.*

as an established law, that the width of the coils had no influence on the magnetic power, though they were arranged in any of the various positions represented in Figure 1.

IV. From the experiments which have been made to discover the influence of the number of the coils on the magnetising of the iron, it appeared, that the magnetism was proportional to the number of the coils, so that this law may be thus stated;—the total effect of the collective coils encircling a bar of iron, is equal to the sum of the effects of each single coil.

The results as to the discovery of the maximum of power which have been established and deduced by algebraic formulas, were as follows:—that the same was independent of the number of plates and thickness of the wires, that, by the due ordering of the battery, we can arrive at the same maximum, be the wire thick or thin; that, in consequence of the conditions imposed by this arrangement, the number of coils which can be applied is limited; that the mode of coiling is in practice of no importance, provided that the chain be duly arranged, as the thickness alone is of importance; that the maximum corresponds with a certain surface of zinc, which cannot be increased; that the maxima of the magnetism are as the square-roots of the zinc-surfaces, and that by increasing the thickness of the coils, the magnetism can only be increased to a certain limit. As to the expense and consumption of zinc, Faraday has shewn, that the strength of the current is proportioned to the quantity of zinc dissolved in each canal in a given space of time. This consumption knows no maximum, but increases as regards the effect produced, the thinner the wire is, and in proportion to the fewness of the pairs of plates. As far as the expense and consumption of zinc is concerned, when the magnetism is at a maximum, it is wholly indifferent whether that magnetism be attained by means of thin or thick wires, provided only that the number of plates be arranged according to the conditions found on the proper calculations.

The principal result to which all previous experiments have led is, that the iron cylinder being given, we may obtain the same maximum of magnetism, determined by the zinc surface, in innumerable different ways, provided only we adopt the thickness of the wire to the arrangement of the chain; but that the mode in which this maximum is obtained, is wholly without influence on the consumption of zinc.

Jacobi assures Faraday in a letter dated the 21st of June, 1839, that he has succeeded in overcoming the difficulties which the due ordering of the battery presents; and that, according to his former experiments, he required a battery presenting a surface of platina of twenty square feet to obtain one horse-power, but that he hoped to be enabled to attain the same power with one from three to ten square feet. According to the experiments which Lenz and Jacobi instituted, as to the laws of electro-magnets, it appeared, that the attraction of the electro-magnets was proportional to the products of the magnetising currents; or, if these be equal, to the squares of the magnetising currents. From the results of the experiments undertaken with a view to confirm the law, that the attraction of two electro-magnets, or an electro-magnet and a bar of soft iron, was as the squares of the strength of the magnetising currents ; it appears that the attraction of two rectilinear electro-magnets, or of an electro-magnet and an anchor, is as the squares of the magnetising streams, provided they both do not touch, but continue at the distance of about a line from one another.

Jacobi's latest experiments on the chemical and magnetic galvanometer confirm the law, that the chemical forces are exactly proportional to the magnetical, and that we can deduce a standard for the consumption of zinc from the indications of a magnetic needle, submitted to the influence of the magnetic currents employed. But the consumption of zinc being proportional to the expenses of maintenance, we can accordingly deduce the cost of working the machine from the magnetic needle.

The first machine constructed by Jacobi, and set in motion by means of electro-magnetism, was on the following plan. *(See plate.)*

The principal figure of the plate represents a magnetical apparatus, in which eight bars (four bars of soft iron in the shape of horse-shoes) are symmetrically attached to a wooden frame, revolving round a horizontal axle, A, and eight other similar, arranged on a sufficiently strong fixed frame. The arrangement of the cylinders admits of every possible variety, it being only necessary that they be symmetrically arranged, and that their poles shall pass each other as closely as possible. Since in all probability the centre of the magnetical gravity is situated at some little distance from the extremity, as is the case with the ordinary magnetic bars, it would be better to arrange it so that the axes of the cylindrical bars should be at right angles to one another, instead of parallel, as in the figure. It must likewise be observed, that there is some difficulty in procuring cylinders of a horse-shoe shape,* so that the axes of the bars be exactly at the same distance, and the bars themselves exactly cylindrical ; all repairs by

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* This relates to Germany.

means of filing or hammering may possibly prove injurious, by hardening the surface of the iron, and thereby rendering it less susceptible of magnetism. The form given in the plate is attended with some other inconveniences, as regards the formation of the spiral line of copper wire, which must be first bent over another cylinder of the same dimensions. These spirals must be quite close to the cylinder, but be preserved from contact with it by being wrapped in silk for the sake of isolation. In future the arrangements represented in figure 2, will be preferred, in which *f f* are stationary cylinders, and *m m* the cylinders revolving round the axle *d.* By this means cylindrical bars of soft iron may be used, to obtain which can be a matter of no difficulty, as they are to be had of all dimensions ready formed. There will then be nothing further necessary than to cut them to the proper length, and bend the spirals round them by means of a lathe or otherwise.

The several bars attached to the moveable and stationary frames are then converted into electro-magnets, by being encircled by the wire of a voltaic battery, and their extremities are north and south poles alternately. If, then, a slight impulse be given to the moveable frame, it will continue to revolve in the direction given, until the contrary poles come opposite one another, after a few oscillations the motion would be suspended, were it not, that, by means of an ingenious contrivance of Jacobi, which he terms the "*Commutator,*" the moment dissimilar poles come opposite one another, the poles of the moveable or stationary bars are reversed, and thus the original conditions of motion are renewed.

Figure 3 gives a side and a front view of the Commutator. *a b c d* are four plates of copper, attached to the rotatory axle, *e e,* which likewise bears the frame on which the electro-magnets are fastened; the plates *a* and *b,* as well as the plates *c* and *d,* are connected by copper tubes, *f f,* and each pair of plates perfectly separated from the other by the interposition of a hollow axle of japanned wood, or any similar isolating substance. The edge of each plate is accurately divided into eight parts, four of which, *h h h h,* are cut out, and duly filled with ebony, so that the sectors and the metal present a perfectly even surface. The plates are so arranged on the axle, that the sectors of wood and metal alternately correspond, as exhibited by the figure, *Z Z. C C,* are copper levers, very moveable round their axes, and serving to conduct the current of the voltaic battery. Each lever is shaped like a hammer at the end, which rests on a corresponding plate. The shorter arm is bent, and dips into the vessel *k,* filled with mercury. The vessels *k k* and *k k*, are, as appears by the plate, connected with one another by means of a copper wire.

The action of the *Commutator* will be now readily understood. The levers are in constant connexion with the plates, but touch the metallic and isolating parts alternately. As they readily move round their axes, they fly from the slightest inequality of surface, and the friction which is thereby caused is very trifling. The spiral coils which encircle the moveable bars are united to one wire, branches of which (*l m*) are soldered to the pairs of plates, *a b* and *c d*. The other spirals, encircling the fixed bars, are similarly joined, and the ends *n* and *o* dip the one into a vessel of quicksilver, *p*, which is connected with the voltaic apparatus, and the other into the vessel *k* of the *Commutator.* Thus, by means of the Commutator, the whole sixteen spirals form but one connecting wire. The voltaic apparatus consists of four troughs of copper, into which four plates of zinc dip. The direction of the current is pointed out in figure 3, by the small darts. As soon as the large wooden frame is turned by the power of the voltaic pile, the Commutator, which is attached to the same axis, will be likewise set in motion, and thus the reversal of the poles effected by means of the machine itself, provided that the commutation plates be so constructed that the extremities of the levers shall pass from one sector to the other.

In September, 1837, by advice of the Minister of Public Instruction in Russia, a commission, consisting of Rear Admiral von Krusenstern, the Academicians, Foss, Ostragradski, Kupfer, and Lenz, Colonel Sololewski, and Lieutenant-Colonel Buratschock were appointed, under the guidance of Professor Jacobi, of Dorpat, with a view to endeavour, by experiment, to render electro-magnetism applicable to the working of machinery, and particularly to the propulsion of ships. The object of this commission appears in part obtained, as on the 25th of September, 1838, a vessel was set in motion on the Neva. An eight-oared galley, such as is usual in the navy, was placed at the disposal of the commission, 28 feet in length and 7¼ in breadth; it was provided with paddles similar to those of a steampacket, and the various apparatus were put on board. The insufficiency of many of the arrangements which had been made, was then, for the first time, apparent, and, in consequence, the first experiment was in a measure proportionably unsuccessful. It had been intended to make experiments only in still water, but they succeeded in propelling the vessel on the Neva, even against the stream. The speed attained in still water was three English miles per hour, and would have been greater had the weight on board, which was large, been properly distributed throughout the boat, which drew 2½ feet of water. The machine, when on board, occupied a space 12½ feet in breadth, and 2½ in length.

The battery consisted of 320 pairs of plates, arranged along the sides of the boat, leaving sufficient room for twelve persons. The whole battery could be brought into play only for a short time, in consequence of a trifling fault in the connexion, which it was impossible to correct on the spot. The consumption of zinc, or rather the production of vitriol of zinc, per horse power, could not be exactly ascertained; but it would appear from the experiments, that this could not be very considerable, inasmuch as the original weight of the zinc being 400 pounds, and presenting a surface of 96 square feet, had decreased but 24 pounds in weight, during from two to three months that the experiments were continued.

Provided the health of Professor Jacobi allow him, he intends constructing an electro-magnetic machine of 40 to 50-horse power, and to adapt it to the propulsion of a vessel.

We must also mention Cyprian Callet's (of New York) electro-magnetic machine. (Patent 11th July, 1838.) On a balance, similar to that of a steam-engine, connecting rods are attached at both sides, which are again connected with strong iron bars, shaped like the shoulders of a Brahmah pump. These bars are firmly encircled by electro-magnetic spiral coils. From another point of the balancer a connecting rod passed to the crank in the horizontal axle of a fly-wheel; and commutation wheels, on Jacobi's principle, are attached to the same, in order to transfer the electric currents from the battery to the spirals. As soon as an electric current is conveyed by means of one of the spirals, the bar, which is already in a measure encircled, is driven with considerable force into the spiral, and a power is thereby engendered, which, from the fly-wheel, may be applied to the propulsion of boats, vehicles, machinery, &c.

According to a written communication from Forbes, addressed to Faraday, dated October 7th, 1839, it would seem that R. Davidson has for the last two years had a small waggon and a lathe propelled by an electro-magnetic machine. The galvanic battery for the foregoing consists of a square foot of zinc surface, and the lathe is of sufficient power to turn small articles, Davidson is said to be the first who attempted to produce motion, not by reversing the poles, but by a momentary suspension of the magnetic virtue.

Davenport, who has constructed the most powerful machines propelled by electro-magnetism, is said to have already applied some smaller ones to different objects, such as the working of printing-presses, principally of a few horse power. As Davenport's machines are at present the most powerful and simple, it is but fair to give a description of them here.

1. Rotatory machines, consisting of moveable electro-magnets and stationary magnets.

The moveable part of this machine consists of two horizontally-placed iron bars, crossing each other at right angles. They are both fifty-two inches long, and pass at each end into a spherical segment of soft iron. The sectors of each of these segments are three inches long, and their position horizontal, being attached to the iron rods.

This iron cross rests upon a perpendicular axle, round which it moves with ease: the iron cross-poles are encircled with coils of copper wire, round which cotton has been spun; and they may be brought in connection with a small battery consisting of concentric copper and zinc cylinders, which can be inserted in a quart of diluted acid. Two semicircles of strongly magnetized iron form a circle, except at the opposite poles; and within this horizontal circle the galvanized iron cross moves, so that its iron segments move parallel, and close to the magnetic circle, and likewise in the same plane. Its axis is provided at the upper end with a cog-wheel, on whose horizontal axle weights are suspended, which are raised by the coiling of a rope. As soon as the battery is duly provided with diluted acid, and set in connection with the machine, the action and motion commence, by means of the iron cross revolving with its segments or flanks By means of the galvanic battery, the crosses and segments are magnetized; in other words, they acquire at their opposite extremities positive and negative polarity; and as they are exposed to the powers of attraction and repulsion of magnets fastened in a circle, a rapid horizontal motion necessarily ensues.

If the battery be small, 200 to 300 revolutions take place in one minute, and 600 if a larger one be employed. The rope with a 14lbs. weight attached, was coiled up, and 28lbs. raised from the ground. The motion instantly ceases, on the connection with the battery being interrupted; and it may be reversed by merely making the wires of the battery change place with those of the machine: the motion then takes place with the same rapidity, but in a contrary direction.

2. Rotatory machines consisting solely of electro-magnets.

Mr. Davenport exhibited a machine of this kind in New York, March, 1837. The only difference between it and the one just described is, that the stationary circle of magnets of the former is supplied by one of electro-magnets in this, and the external circle of soft iron divided into two to form the poles. These semicircles are one-eighth of an inch thick, one inch broad, encircled in copper wire, and isolated by cotton. This wire extends over about ten inches of each circle; and, by being coiled back upon itself, presents two shafts of wire, amounting on both semicircles to about 1500 inches.

The iron of the semicircles is not entirely encircled, but the ends are left naked and bent inwards, as represented in figure 5 : each of the ends bent in is about one-sixth of the semicircle. The semicircles thus formed may, if desired, be converted into electro-magnets, and are substituted in the place of permanent steel magnets in the former machine. In order to obviate the necessity of having two batteries, the conducting wires are so arranged that the same current which supplies the magnets of the fly-wheel, also supply the stationary magnets which surround it. The stationary galvanic magnets by which the place of the steel magnets is supplied, are only half as heavy as the former. With a battery which could be immersed in a quart of diluted acid, the apparatus raised 16lbs. very rapidly ; and, without the weight, executed 600 evolutions in a minute. The machine was so sensitive of magnetic power that it went with considerable speed when the battery was sunk but an inch deep into the acid. When provided with electro-magnets the effect seemed more powerful than with the ordinary magnets.

We are indebted for a great improvement in electro-magnetic machines to the mechanician Stoehrer, of Leipsic, who has constructed a machine as a model, the perfect simplicity and easy construction of which will in all probability insure its application in the room of all other moving powers. It is worked at present but by four elements, each consisting of a copper cylinder filled with vitriolic acid in which a zinc plate is hung, and sets a lathe in motion, which is applied to the turning of small brass articles. The expense of this power for twenty-four hours is one shilling, one-half of which is fully covered by the pure metallic copper which is obtained.

Stoehrer constructed his model last year on the principles laid down by Jacobi; and some time after, Wagener, of Frankfort, constructed a similar model, for which a reward of 100,000 florins was guaranteed him by the German Diet, as soon as the plan should be carried out on a large scale.

This execution on a large scale has, according to the latest accounts, succeeded most brilliantly; for a saw-mill is at present worked by electro-magnetism in Bavaria, and this new power has already realized the most sanguine expectations. A locomotive is also propelled by it.

It is therefore to be expected that electro-magnetism will soon play an important part, and unquestionably supersede steam, which is so much more dangerous and expensive, and every other power with which we are as yet acquainted. Stoehrer is convinced that, with 100 zinc elements, as above mentioned, (equal to forty-five horse power,) he can propel a train of waggons with the usual number of passengers, from Leipsic to Dresden on the railroad, at an expense of but six shillings, whilst the expense at present is about five pounds sterling.

We thus arrive at a standard of the extraordinary economy and power of these new machines: notwithstanding their immense power, they, can, nevertheless, be instantly stopped by a child; nothing further being necessary to stop the machine than to lift the connecting-rod out of the vessel.

The extent by which this power may yet be, and must in time be perfected is sufficiently clear, from the fact of its being applicable, with the greatest advantage, for grinding, turning, spinning, and innumerable other mechanical processes.

We feel therefore justified in calling the attention of mechanics to this novel power; and we hope by the aid of the drawings (which we have taken principally from Jacobi) to enable any one to get such machines made. Herr Stoehrer, in Leipsic, undertakes to construct such machines.

The following has been selected from an article in the Polytechnisches Centralblatt, which we doubt not will be read with interest.

On Electro-Magnetic Machines. By EMIL STOEHRER, *of Leipzig, Mechanician.*

It would seem as if the construction of electro-magnetic machines was regarded as a secret everywhere, inasmuch as different means are employed to attain the same end each person is entitled to protection for all that is peculiar in his mode of construction. But, since the laborious efforts of Messrs. Jacobi and Lenz, in St. Petersburgh have succeeded in defining the laws which govern the strength and power of the electro-magnets; and since those gentlemen have published the same to the world, it is within the power of every one versed in mechanics, and acquainted with the theory of galvanism and electro-magnetism, to construct electro-magnetic machines of tolerable efficiency.

Besides, it is well known that the late experiments of Messrs. Jacobi and Lenz have been eminently successful. The same boat, twenty-eight feet long, seven and a half broad, and two and three quarter deep, carrying fourteen persons, which in 1838 was set in motion by a copper and zinc battery of 320 pair of plates, each plate measuring 28 square inches, was propelled, in the autumn of 1839, by a battery of zinc and platina, on Groves's plan, consisting of 64 pair of plates, each plate measuring 36 square inches, by means of a judicious alteration in the arrangement of the bars, attained a rapidity of two miles and three quarter an hour, against the stream; being almost equal to the speed of a steam-boat on the Neva, where the experiment was made. In the next place, we know on good authority, that an electro-magnetic machine has been long since applied in Philadelphia to the working of a printing-press; and there can be hardly any doubt but that, up to the present moment, some further progress has there been made.

Since the beginning of last year, I also have made numerous experiments; and am at this moment engaged in the construction of a good-sized machine, according to the calculations of Messrs. Jacobi and Lenz. With a view of contributing something to the diffusion of a general acquaintance with this wondrous machine, I shall take the liberty of communicating the following results at which I have arrived.

The model of an electro-magnetic machine was set in motion by means of a constant battery, constructed for technical purposes, and presenting a zinc surface of ninety-nine square inches, and raised, in the space of one minute, two pounds weight to a height of three feet. By means of three elements, each ninety-nine square inches in superficies, the same battery raised seven pounds in one minute three feet high. The electro-magnets applied are in the form of bars, and care had been taken that they should possess the largest polar surface possible, and pass each other as closely as possible. The number of the revolutions with one element amounted to 100 in one minute, and with three elements to 250 in the same space of time. During twelve hours of unintermitting action with one element, a quarter of a pound of blue vitriol was decomposed, and the copper therein contained precipitated.

Experiment has shown that this secondary product fully covers the loss of zinc incurred during the same time. By employing one element, which does not cost more than three-half-pence daily, 1440 pounds may be raised to a height of three feet in twelve hours. A battery and machine, to suit technical purposes is regulated as follows:

1. By lifting up the connecting-wire the whole action is suspended, and all motion instantly ceases.
2. Arrangements are made so that the machine can work with any intermediate power from the *minimum* to the *maximum,* without its consuming a greater quantity of blue vitriol than is exactly requisite for the power required.
3. A battery can continue for twelve hours in perfectly equable operation, provided that the vitriol be supplied once a day.
4. The solution always remains in the holders of the battery in a saturated state, so that the machine may be instantly set in motion by the inserting of the zinc, and without its being necessary to resort to a new solution of the vitriol.
5. The battery is free from the inconvenience of generating noxious gas, so that the machine may be set in operation in a room, without causing the slightest smell of any kind.
6. Arrangements may be made for the removal of the precipitate of copper from time to time, and so applied to any purpose.
7. When the machine is not in action, the zinc can be easily removed, and suspended over the machine: no cleansing is necessary until the zinc be completely dissolved.

If we can no longer doubt, after the experiments of Messrs. Jacobi and Lenz, that the effect of the electro-magnetic machines increased in proportion to the squares of the number of the elements of the batteries, they must, when executed on a large scale, prove very economical, independent of the outlay of capital and the cost of repairs being so much less than with steam-engines.

A power which can raise two pounds weight three feet high in one minute, will raise six pounds one foot high in the same time. As only one element of the battery is required to effect this, let this be considered as unity, and the first member of the following progression, which may serve as the basis of the construction of electro-magnetic machines. The dimensions of the whole machine must naturally be in proportion to the increase of the elements. Since, according to Jacobi, the power of the machine increases with the quadratic relations of the number of elements, it is clear likewise, that the power may be increased by a proportional enlargement of the machine. The numbers of the following table must be accordingly multiplied by the number which would represent the enlargement.

Number of battery Elements.	Pounds weight raised one foot high.	Number of battery Elements.	Pounds weight raised one foot high.
1	6	23	3174
2	24	24	3456
3	54	28	4704
4	96	32	6144
5	150	36	7776
6	216	40	9600
7	294	44	11616
8	384	48	13824
9	486	52	16224
10	600	56	18816
11	626	60	21600
12	864	64	24576
13	1014	68	27744
14	1116	72	31104
15	1330	76	34656
16	1536	80	38400
17	1731	84	42336
18	1944	88	46464
19	2106	92	50784
20	2400	96	55296
21	2766	100	60000
22	3904		

As one element costs three-half-pence daily, we may thence deduce the expenses of the machine with ease. A machine, the magnets of which were twenty-five times the size of the model, would accordingly, with 100 elements, or for 12*s.* 6*d.*, (the half of which is covered by the copper,) exert a power equal to forty-five horses.

Experience will hereafter show in how far the calculations which have been made from models will coincide with reality. So much, however, is certain, that, when the advantages come in practice at all near the calculations, there can be no means of producing motion so cheap and convenient as electro-magnetism.

In a conversation which the translator had with the above-mentioned Herr Stoehrer, that gentleman informed him that he was then engaged in constructing a locomotive for the Leipsic and Dresden railway, by order of the Company. He was, however, of opinion that it would be more judicious to divide the power amongst several smaller machines, than to concentrate it in one large machine. He seemed surprised that

England, possessing, as she does, the most enormous capital for the purposes of experiment, should remain so indifferent on a subject of such vast importance. He has obtained a patent for his invention throughout the kingdom of Saxony.

Address of the President, SIR J. F. W. HERSCHEL, BART. *on the presentation of the Gold Medal of the Royal Astronomical Society, to Professor* BESSEL, *at the Anniversary Meeting, February* 12, 1841, *for his observations and researches on the Parallax of* 61 *Cygni.*

GENTLEMEN,—The Report of the Council has placed before you so ample a view of the state of the Society, of its labours during the last year, of the accessions to its members, and of the many and severe losses it has had to deplore, that little is left for me to add, except my congratulations on its continued and increasing prosperity. It would be inexpressibly gratifying to me if I could persuade myself that my own exertions in its chair had contributed, even in a small degree, to that prosperity; but, alas! I have felt only too sensibly how very feebly and inefficiently, especially during the last year, owing to a variety of causes, but chiefly to residence at a distance from London, I have been able to fill that most honourable office.

The immediate object of my now addressing you, Gentlemen, is to declare the award by your Council of the gold medal of this Society to our eminent associate, Mr. Bessel, for his researches on the annual parallax of that remarkable double-star 61 *Cygni,*—researches which it is the opinion of your Council have gone so far to establish the existence and to measure the quantity of a periodical fluctuation, annual in its period and identical in its law with parallax, as to leave no reasonable ground for doubt as to the reality of such fluctuation, as something different from mere instrumental or observational error: an inequality, in short, which, if it be *not* parallax, is so inseparably mixed up with that effect as to leave us without any criterion by which to distinguish them. Now, in such a case, parallax stands to us in the nature of a *vera causa,* and the rules of philosophizing will not justify us in referring the observed effect to an unknown, and, so far as we can see, an inconceivable cause, when this is at hand, ready to account for the whole effect.

I say, in the nature of a *vera causa,* since each particular star must of necessity have some parallax. Every *real, existing, material* body, must enjoy that indefeasible attribute of body, viz. *definite place.* Now place is defined by *direction* and *distance* from a fixed point. Every body, therefore, which does exist, exists at a certain definite distance from us and at no other, either more or less. The distance of every individual *body* in the universe from us is, therefore, necessarily admitted to be finite.

But though the distance of each particular star be not in strictness infinite, it is yet a real and immense accession to our knowledge to have *measured* it in any one case. To accomplish this, has been the object of every astronomer's highest aspirations ever since sidereal astronomy acquired any degree of precision. But hitherto it has been an object which, like the fleeting fires that dazzle and mislead the benighted wanderer, has seemed to suffer the semblance of an approach only to elude his seizure when apparently just within his grasp, continually hovering just beyond the limits of his distinct apprehension, and so leading him on in hopeless, endless, and exhausting pursuit.

The pursuit, however, though eager and laborious, has been far from unproductive, even in those stages where its immediate object has been baffled.

The fact of a periodical fluctuation of *some kind* in the apparent places of the stars was recognized by Flamsteed, and erroneously attributed to parallax. The nearer examination of this phenomenon with far more delicate instruments, infinitely greater refinement of method, and clearer views of the geometrical relations of the subject, rewarded Bradley with his grand discoveries of aberration and nutation, and enabled him to restrict the amount of possible parallax of the stars observed by him within extremely narrow limits.

Bradley failed to detect any appreciable parallax, though he considered 1″ as an amount which would not have escaped his notice. And since his time this quantity has been assumed as a kind of conventional limit, which it might be expected to attain, but hardly to surpass. But this was rather because, in the best observations from Bradley's time forward, 1″ has been a tolerated error; a quantity for which observation and mechanism, joined to atmospheric fluctuations and uncertainties of reduction, could not be held rigidly accountable even in mean results; than from any reason in the nature of the case, or any distinct perception of its reality. If parallax were to be detected at all by observations of the absolute places of the stars, it could only emerge as a "residual phenomenon," after clearing away all the effects of the uranographical corrections as well as of refraction, when it would remain mixed up with whatever uncertainties might remain as to the coefficients of the former, with the casual irregularities of the latter, and with all the forms of instrumental and observational error. Now these have hitherto proved sufficiently even in the observation of zenith stars, quite to overlay and conceal that minute quantity of which astronomers were in search.

It is not my intention, Gentlemen, to enter minutely into the history of the attempts of various astronomers on this problem, whether by the discussion of observations of one star, or by the combination of those of pairs of stars opposite in right ascension; nor with the occasional gleams of apparent success which, however, have always proved illusory, which have attended these attempts. For such a history, and, indeed, for a complete and admirably drawn-up monograph of the whole subject, I must refer to a paper lately read to this Society by Mr. Main, and which is now in process of publication in the forthcoming volume of our *Memoirs*. In whatever reference I may have to make to the history of the subject, I must take this opportunity to acknowledge my obligations to the author of this paper, as well as for his exceedingly luminous exposition of the results of those more successful attempts on the problem by Henderson, Struve, and Bessel, which I shall now proceed more especially to consider.

It would be wrong, however, not to notice that the first indication of some degree of impression beginning to be made on the problem seems to be found in Struve's discussion of the differences of right ascension of circompolar stars in 1819, 20, and 21. The only *positive* result, indeed, of these observations is, that in the case of twenty-seven stars examined, none has a parallax amounting to half a second. But *below* this, there certainly do seem to be indications in the nature of a real parallax, which might at least suffice to raise the sinking hopes of astronomers, and excite them to further efforts.

But the time arrived when the problem was to be attacked from a quarter offering far greater advantages, and exposed to few or none of those unmanageable sources of irregular error to which the determinations of absolute places are liable. I mean by the measurement of the distances of such double stars as consist of individuals so different in magnitude as to authorize a belief of their being placed at very different distances from the eye; or, as Struve expresses it, *optically* and not *physically* double. This, in fact, was the original notion which led to the micrometrical measurements of double stars: but not only was anything like a fair trial of the method precluded by the imperfections of all the micrometers in use until recently, but the interesting phenomena of another kind, which began to unfold themselves in the progress of those measurements, led attention off altogether from this their original application, which thus lay dormant and neglected, until the capital modern improvements, both in the optical and mechanical parts of refracting telescopes, and the great precision which it was found practicable, by their aid, to attain in these delicate measurements, revived the idea of giving this method, what it never before had, a fair trial. The principle on which the determination of parallax by means of micrometrical observations of a double star turns, is extremely simple. If we conceive two stars very nearly in a line with the eye, but of which one is vastly more remote than the other, each by the effect of parallax, will appear to describe annually a small ellipse about the mean place as its centre. These two ellipses, however, though similar in form will differ in dimension; that described by the more remote star being comparatively much smaller: consequently, the apparent places being similarly situated in each, their apparent distance on the line joining these apparent places will both oscillate in angular position and fluctuate in length, thus giving rise to an annual relative alternate movement between the individuals both in position and distance, which is greater the greater the difference of the parallaxes.

Thus it is not the absolute parallax of either, but the difference of their parallaxes, which is effectively measured by this method; *i. e.* by repeating the measurements of their mutual distance at all times of the year. But, on the other hand, aberration, nutation, precession, and refraction, act equally on both stars, or so very nearly so as to leave only an exceedingly small fraction of these corrections bearing on the results. And when the stars are very unequal in magnitude, there is a presumption that the difference of their parallaxes is very nearly to the whole parallax of the nearer one.

The selection of a star for observation involves many considerations. In that pitched on by M. Bessel (61 *Cygni*), the *large star* so designated, is in fact a fine double star; nay, one that has been ascertained to be physically double. It is in every respect a highly remarkable star. The mutual distance of its individuals is great, being about $16\frac{1}{4}''$. Now this being necessarily less than the axis of their mutual orbit, affords in itself a presumption that the star is a *near one.* And this presumption is increased by the unusually great proper motion of this binary system, which amounts to nearly 5" per annum, and which has been made by Sir James South the subject of particular inquiry, and found to be *not* participated in by several small surrounding stars, *which, therefore,* are not physically connected with it. Moreover, the angular rotation of the two, one about the other, has been well ascertained.

Now, it fortunately happens, that of these small surrounding stars there are two very advantageously situated for micrometrical comparison with either of the individuals of the binary star, or with the middle point between them. The one of these (*a*), at a distance of 7, 42″, is situated nearly at right angles to the direction of the double star; the other (*b*) at a distance of 11′ 46″, nearly *in* that direction. Considering (*a*) and (*b*) as fixed points then, and measuring at any instant of time their distances from (*c*), the middle point of the double star, the situation of (*c*) relative to (*a*) and (*b*) is ascertained; and if this be done at every instant, the relative *locus* of (*c*), or the curve described by it on the plane of the heaven with respect to the fixed base-line *a b,* will become known.

Now, on the hypothesis of parallax, that locus ought to be an ellipse of one certain calculable eccentricity and no other. And its major and minor axis ought to hold with respect to the points, *a*, *b*, certain calculable positions and no other. Hence it follows that the distances *a c* and *b c* will each of them be subject to annual increase and diminution ; and *that,* 1st, in a given and calculable ratio the one to the other; and, 2ndly, so that the maxima and minima of the one distance (*a c*) shall be nearly contemporaneous with the *mean* values of the other distance *b c*, and *vice versâ*.

Thus we have, in the first place, several particulars independent of mere numerical magnitudes ; and, in the second place, several distinct relations *à priori* determined, to which those numerical values must conform, if it be true that any observed fluctuations in these distances (*a b*) (*a c*) be really parallactic. So that if they be found in such conformity, and the above-mentioned maxima and minima do observe that interchangeable law above stated : and if, moreover, all due care be proved to have been taken to eliminate every instrumental source of annual fluctuation ; there becomes accumulated a body of probability in four of the resulting parallax, which cannot but impress every reasonable mind with a strong degree of belief and conviction.

Now, all these circumstances have been found by M. Bessel, in his discussion of the measures taken by him (which have been very carefully and rigorously examined by Mr. Main in the paper alluded to, as have also M. Bessel's formulæ and calculations, for in such matters nothing must remain unverified), to prevail in a very signal and satisfactory manner. Not one case of discordance, in so many independent particulars, have been found to subsist ; and this, of itself, is high ground of probability. But we may go much farther. Mr. Main has projected graphically the deviations of the distances (*a c*) and (*b c*) from their mean quantities (after clearing them of the effects of proper motion and of the minute differences of aberration, &c.). Taking the time for an abscissa, and laying down the deviations in the distances so cleared as ordinates, two curves are obtained, the one for the star (*a*), the other for the star (*b*). Each of these curves ought alternately to lie for half a year above, and for half a year below, it axis.—*It does so.* Each of them ought to intersect its axis at those dates when the maximum and minimum of the other above and below the axis occurs. With only a slight degree of hesitation at one crossing—*it does so.* The points of intersection with the axis ought to occur at dates in like manner calculated *à priori;* and so they do within very negligible limits of error. And, lastly, the general forms, magnitudes and flexures of the curves ought to be identical with those of curves similarly projected, by calculation on an assumed resulting parallactic coefficient. This is the final and severe test: Mr. Main has applied it, and the results have been placed before you:—*oculis subjecta fidelibus.* If all this does not carry conviction along with it, it seems difficult to say what ought to do so.

The only thing that can possibly be cavilled at is the shortness of the period embraced by the observations: viz. from August 1837 to the end of March 1840. But this interval admits of five intersections of each curve with its axis; of two maxima and two minima in its excursions on either side; and of ample room for trying its agreement in general form with the true parallactic curves. Under such circumstances, it is quite out of the question to declare the whole phenomenon an accident or an illusion. *Something* has assuredly been discovered, and if that something be not parallax, we are altogether at fault, and know not what other cause to ascribe it to.

The instrument with which Bessel made these most remarkable observations is a heliometer of large dimensions, and with an exquisite object-glass by Fraunhofer. I well remember to have seen this object-glass at Munich before it was cut, and to have been not a little amazed at the boldness of the maker who would devote a glass which at that time would have been considered in England almost invaluable, to so hazardous an operation. Little did I then imagine the noble purpose it was destined to accomplish. By the nature and construction of this instrument, especially when driven by clock-work, almost every conceivable error which can affect a micrometrical measure is destroyed, when properly used; and the precaution taken by M. Bessel in its use have been such as might be expected from his consummate skill. The only possible apparent opening for an annually fluctuating error seems to be in the correction for temperature of its scale. But this correction has been ascertained by M. Bessel by direct observation, in hot and cold seasons, and applied. Nor could this cause destroy the evidence arising from the simultaneous observation of the two companion stars, since a wrong correction for temperature would affect both their distances proportionally, leaving the apparent parallactic movement still unaccounted for.

The resulting parallax is an extremely minute quantity, only thirty-one hundredths of a second; which would place the star in question at a distance from us of nearly 670,000 times that of the sun !* Such is the universe in which we exist, and which we have at length found the means to subject to measurement, at least in one of its members probably nearer to us than the rest.

It becomes necessary for me now to refer to two series of researches on this important subject, which have been held by your Council to merit very high and honourable mention ; though neither of them, separately, for reasons which I shall state, would have been considered as carrying that weight of probability in favour of its conclusions, which would justify any immediate decision of the nature which they have come to in the case of M. Bessel's. I allude to M. Struve's inquiries, by the method of micrometric measures, into the parallax of *a Lyræ* : and to Mr. Henderson's, by that of meridian observations, on the parallax of *a Centauri.*

a Lyræ is accompanied by a very minute star, at the distance of about 43″. That this star is unconnected with *a* by any physical relation, is clear from the fact ascertained by Sir James South and myself, that it does not participate in the proper motion of the large star. The mutual angular distance of these stars has been made by M. Struve the subject of a very extensive series of micrometric measures with the celebrated Dorpat achromatic, bearing this object steadily in view, and working it out to a conclusion of the very same kind, and, though materially inferior in the degree and nature of its evidence to that of Bessel, yet certainly entitled to high consideration. M. Struve's observations on this star, and for this purpose, extend from Nov. 1835 to Aug. 1838, and are distributed over sixty nights, averaging twenty per annum ; and from their combination, according to the principle of probabilities, he concludes a parallax of 0″·261. Mr. Main has subjected these observations to an analysis and graphical projection, precisely similar in principle to those

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* The orbit described by the two stars of 61 *Cygni* about each other will, therefore, be about 50 times the diameter of the earth's about the sun, or 2½ times that of *Uranus.*

I have explained in the case of 61 *Cygni*. The curves so projected have been subjected to your inspection, and that inspection certainly does leave a very strong impression of a real and tolerably well-ascertained parallax *having* been detected in this star. But at the same time an impression no less decided, owing to irregularities in the march of the curve, when compared with the true parallactic curve, is created,—that the errors of observation are far from being eliminated,—that, on the contrary, they bear such a proportion to the parallax itself as to leave room for some degree of hesitation, and to justify an appeal to a longer series of observations, and to concurrent evidence from other quarters, before declaring any positive opinion. The evidence of this kind, in short, is not equal to that afforded by the similar projection of Bessel's observations of *either* of his two comparison stars. And to this it must be added, that only one star of comparison existing in the line of *α Lyræ,* the possible effect of temperature and *annual* instrumental variation is not eliminated from the result in the way in which it is from the measures of 61 *Cygni;* while all that great mutual support which the observations of parallaxes of the two comparison stars afford each other in the latter case, is altogether wanting in the former. These considerations, without any under-estimation of the great importance and value of M. Struve's researches yet formed essential drawbacks on the immediate admission of his results.

In a word, I conceive the question of discovery as between these illustrious, but most generous and amicable rivals, may be thus fairly stated. M. Struve's meridian observations in 1819-1821 seem to have made the first impression on the general problem, but too slight to authorize more than a hope that it would yield at no distant day. His micrometric measures of *α Lyræ* commenced more than a year earlier, and have extended altogether over a longer period than M. Bessel's of 61 *Cygni*. From their commencement they afford indications of parallax, and these indications accumulating with time have amounted to a high degree of probability, and rendered the supposition of parallax more admissible than that of instrumental or casual errors producing the same influence on the measures. On the other hand, M. Bessel's measures commencing a year later, and continued on the whole through somewhat less time, have exhibited a compact and consistent body of evidence drawn from two distinct systems of measures mutually supporting each other, and so steadily bearing on their object as to leave no more reasonable doubt of its truth than in the case of many things which we look upon as, humanly speaking, certain. And this conviction once obtained, reacts on our belief in the other results, and induces us to receive and admit it on the evidence adduced for it; which, without such conviction so obtained, we might hesitate to do until after longer corroboration of the same kind.

The other series of observations to which I must now call your attention are those of Mr. Henderson, made at the Cape of Good Hope, on the great star *α Centauri*, the third star in brightness which the heavens offer to our view. It is a magnificent double star consisting of two individuals, the one of a high and somewhat brownish orange, the other of a fine yellow colour, and each of which I consider fairly entitled to be classed in the first magnitude.* Their distance is at present about 15″ asunder, but it is rapidly diminishing, and in no great lapse of time they will probably occult one another, their angular motion being comparatively small. Their apparent distance was formerly much greater: how much we cannot say for want of observations, but probably the major axis of their mutual orbit is little short of a minute of space. They, therefore, afford strong indications of being very near our system. Add to which their proper motion is very considerable, and participated in by both, which proves their connexion as a binary system; and an additional presumption in favour of their proximity may be drawn from their situation in what, from general aspect, I gather to be the nearest region of the milky way, among an immensity of large stars.

Mr. Henderson observed these stars with great care both in right ascension and declination with the very fine transit, and (in spite of certain grievous defects in the axis) the otherwise really good and finely divided mural circle of the Royal Observatory in that colony. Since his return to England, he has reduced these observations with a view to parallax, and the result is the apparent existence of that

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* I have seen *both* their images projected on a screen of three thicknesses of stout paper, the eye being on the opposite side of the screen from that on which the images were depicted

element to what, after what has been said, we must now call the great and conspicuous amount of a full second. Mr. Main, to whom I am so largely indebted for allowing me to draw so freely on his labours, has also discussed these results, and comes to the conclusion that (as might, perhaps, be expected) the right-ascension observations afford a trace, but an equivocal one, of parallax, but that in declination (I use his words) "The law of parallax is followed remarkably well. There is scarcely an exception to the proper change of sign, according to the change of sign of the coefficients of parallax. This is quite as much as can reasonably be expected in a series of individual results obtained from any meridional instrument for observing zenith distances. We cannot expect to find the periodical function regularly exhibited by the differences. On the whole, therefore, we should say that, in addition to the claims of *α Centauri* on our attention with relation to its parallax, arising from its forming a binary system, its great proper motion, and its brightness,—it derives now much additional importance, in this point of view, from the investigation of Mr. Henderson. This we are at least entitled to assume until some distinct reason, independent of parallax, shall have been assigned for the changes in the declinations. Such I do not consider impossible, having before my eyes the results which Dr. Brinkley derived, in the cases of certain stars, from the Dublin circle. For the present it must be considered that the star well deserves a rigorous examination by all the methods which the author himself has so well pointed out; and that, in the event of a parallax at all comparable with that assigned by Mr. Henderson being found, he will deserve the merit of its first discovery, and the warmest thanks of astronomers, as an extender of the knowledge which we possess of our connexion with the sidereal system."

With this view of Mr. Henderson's labours I fully agree, and await with highly excited interest the result of Mr. Maclear's larger and complete series of observations on this star both with the old circle and with that more perfect one with which the munificence of government has recently supplied the Observatory. Should a different eye and a different circle continue to give the same result, we must, of course, acquiesce in the conclusion; and the distinct and entire merit of the *first* discovery of the parallax of *a* fixed star will rest indisputably with Mr. Henderson. At present, however, we should not be justified in so far anticipating a decision which time alone can stamp with the seal of absolute authenticity.

Gentlemen of the Astronomical Society, I congratulate you and myself that we have lived to see the great and hitherto impassable barrier to our excursions into the sidereal universe; that barrier against which we have chafed so long and so vainly—(*æstuantes angusto limite mundi*)—almost simultaneously overleaped at three different points. It is the greatest and most glorious triumph which practical astronomy has ever witnessed. Perhaps I ought not to speak so strongly—perhaps I should hold some reserve in favour of the bare possibility that it may be all an illusion—and that further researches, as they have repeatedly before, so may now fail to substantiate this noble result. But I confess myself unequal to such prudence under such excitement. Let us rather accept the joyful omens of the time, and trust that as the barrier has begun to yield it will speedily be effectually prostrated. Such results are among the fairest flowers of civilization. They justify the vast expenditure of time and talent which have led up to them; they justify the language which men of science hold, or ought to hold, when they appeal to the governments of their respective countries for the liberal devotion of the national means in furtherance of the great objects they propose to accomplish. They enable them not only to hold out but to redeem their promises, when they profess themselves productive labourers in a higher and richer field than that of mere material and physical advantages. It is then when they become (if I may venture on such a figure without irreverence) the messengers from heaven to earth of such stupendous announcements as must strike every one who hears them with almost awful admiration, that they may claim to be listened to when they repeat in every variety of urgent instance, that these are not the last of such announcements which they shall have to communicate,—that there are yet behind, to search out and to declare, not only secrets on nature which shall increase the wealth or power of man, but TRUTHS which shall ennoble the age and the country in which they are divulged, and by dilating the intellect, react on the moral character of mankind. Such truths are things quite as worthy of struggles and sacrifices as many of the objects for which nations contend, and exhaust their physical and moral energies and resources. They are gems of real and durable glory in the diadems of princes, and conquests which, while they leave no tears behind them, continue for ever unalienable.

It must be needless for me to express a hope that these researches will be followed up. Already we have to congratulate astronomy on the resolution taken by one of our great academic institutions to furnish its observatory with an heliometer of the same description as Bessel's; nor can we fear but that the research will speedily be extended to other stars, offering varieties of magnitude, and other indications to draw attention to them.

On the whole, then, the award of our medal, which the Council have agreed on, seems to me, under the circumstances, fully justified. I will now request the foreign secretary to convey it to our distinguished associate; and in so doing, I will add our hope that, in the painful and distressing visitation with which it has pleased Providence recently to try him, he may find occasion to withdraw his mind a while from that melancholy contemplation to receive with satisfaction such a tribute to this his last, and perhaps his greatest achievement, accompanied as it is by the truest regard for his private worth, and the most respectful sympathy for his present distress.

On a Thorny Species of Lizard and other Reptiles from New Holland, described by Mr. Gray. Plate V.

Having been favoured by our friend Dr. Huffnagle with a species of Thorny Lizard, (plate V), we found it to be one of those new Reptiles, brought to notice by Mr. Gould, as inhabitants of New Holland, and which are described by J. E. Gray, Esq., F. R. S. in the Annals and Magazine of Natural History, April 1841. The species is that which is named by Mr. Gray, *Moloch horridus*, and as it has never been figured, we have endeavoured from the specimen presented to us to supply this desideratum, although we regret to say, we have in a great degree failed. The animal in spirits is of a yellow colour, with dark interrupted streaks along the body, which is covered with spines. We here quote Mr. Gray's remarks, in which the description of this curious creature will be found under the name above stated:—

Description of some new Species and four new Genera of Reptiles from Western Australia discovered by John Gould, Esq. By J. E. Gray, Esq., F. R. S., &c.

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,

MR. Gould having kindly placed in my hands the collection of Reptiles which he made during his visit to New Holland to gather materials for his 'History of the Birds of Australia,' I have sent you the description of the following species, which appear to be new to science. The two new genera are very interesting; the one, *Ronia*, being exactly intermediate in organization between the two-legged and the four-legged Scincs; and the other, *Moloch*, for its extraordinary appearance and grotesque forms.

I may remark, this collection contains two specimens of *Soridia lineata*, Gray, which MM. Dumeril and Bibron have accused me of erroneously describing as an Australian animal. (See 'Erpétologie Générale, v. 787.) I believe that this has arisen from M. Bibron supposing all the Reptiles that he saw at the Chatham Museum to be from the Cape of Good Hope; whereas that collection is very rich in Australasian Reptiles. *Chelomeles* of MM. Dumeril and Bibron appears to be very nearly allied to *Soridia*, and should most probably be arranged with it in the family of *Rhodonidæ*.

Mr. Gould's specimens of *Delma* having enabled me to examine more minutely the characters of that genus, I am now convinced that it should be referred to the family *Pygopidæ*. It chiefly differs from the genus *Pygopus* in the small size of the rudimentary feet, and in the absence of the pre-anal glands.

The genus *Lialis*, which heretofore has been placed with *Pygopus*, appears to be the type of a new family. It, *Delma* and *Pygopus* are all found in Western Australia, as is also the genus *Aprasia*, which ought in my Catalogue of Slender-tongued Saurians (Ann. Nat. Hist. vols. i. and ii.), to have been arranged with the Apodel Scincs. On examining Mr. Gould's better-preserved specimen, I am inclined to consider it also as the type of a family characterized by the shields of the head and the position of the nostrils, to which most probably, MM. Dumeril and Bibron's genus *Brachymeles* will also have to be referred. These genera will then range thus :—

Fam. LIALISIDÆ :—*Lialis.*
Fam. PYGOPIDÆ :—*Pygopus, Delma.*
Fam. RHODONIDÆ :—*Rhodona Soridia Chelomeles.*
Fam. APRASIADÆ :—*Aprasia Brachymeles.*

RONIA, Gray. Fam. Scincidæ.

Head rather shelving, shielded with one transverse frontal and two large vertebral plates, the hinder largest; the rostral plates large, with two unequal supercilliary plates. The nasal plate triangular, interposed between the rostral plate and the frontal ones, with the nostrils in its centre; loreal plates two, square; labial plates large; ears none, only a very indistinct sunk dot in their place. Body cylindrical; tail conical, tapering. Scales smooth, ovate, imbricate, of the belly 6-sided. The front limbs very small, rudimentary, undivided; the hinder limbs moderately developed, ending in two very unequal toes, with distinct claws.

Ronia catinulata, Gray. Back with eight series of small black dots, one dot on the centre of each scale; cheeks, black, speckled; sides and beneath whitish.

Body 3½, tail 2½ inches.

Inhab. Western Australia. Mr. J. Gould.

The scales under the tail are rather larger, and the spots on the tail are rather larger than those on the back.

Grammatophora cristata. Nape with a crest of distinct, rather short, curved, compressed, spinose scales; back and tail with a series of compressed scales forming a slight keel; occiput with separate short strong conical spines; sides of the neck and back with folds crowned with series of short compressed scales; base of the tail with some scattered larger scales. In spirits, dull olive; crown black with large white spots, beneath black; middle of the belly and under sides of the base of the tail white; tail with black rings, at the ends; feet whitish.

Inhab. Western Australia. Mr. J. Gould.

The underside is coloured somewhat like *G. maculatus* (*G. Gaimardii*

Dum. and Bibron), but the sides of the head near the ears are spinose, and the nape is distinctly crested. But as MM. Dumeril and Bibron's species is only described from a single specimen, which is in a bad state, and has lost its epidermis, and as the description itself, though long, refers chiefly to parts which do not differ in the species of the genus, this species may prove to be identical with it.

These authors, in giving the character of *Grammatophora Gaimardii* and *G. Decresii*, appear to place great reliance on the one having tubular and the other non-tubular femoral pores, which is a fact entirely dependent on the state in which the animal might be at the time when it was put into the spirits, as I have verified by comparing numerous specimens of different reptiles furnished with these pores.

But in this genus the size of the pores is apparently of less importance than in many others, for they appear to be quite invisible in some states of the animal: thus out of many specimens of *G. muricata* brought by Mr. Gould from Van Diemen's Land and Western Australia, eight specimens have no visible pores; these specimens differ from the others in being of a rather paler colour beneath. This state of the pores may entirely depend on the manner in which they were preserved, for all these specimens had a slit made into their abdomen to admit the spirits; while in all specimens in which this care had not been taken the pores are distinctly seen, sometimes moderately sized, and sometimes tubularly produced.

Grammatophora Decresii, Dumeril and Bibron, Erp. Gén. iv. 472.

Tail conical, with nearly regular scales; the base rather swollen? without any series of spines on the side; back with small subequal scales and a few larger once in cross series; the nape and back with a series of rather larger, low, compressed scales; side of the head near the ears and side of neck with two or three ridges crowned with short conical spines. In spirits black, yellow spotted and varied, beneath gray, vermiculated with blackish; tail black-ringed.

Inhab. Western Australia.

This species is so much smaller than *G. muricata*, that I might have considered them as young animals if one of them had not had the body filled with well-formed eggs; and the tail is much shorter than in the young of that species.

The specimens agree in most points with the description given by MM. Dumeril and Bibron, but not in the colour and the size of the tail. The specimens in this collection greatly differ in their colour, but are all very different from any other species.

Grammatophora muricata, Cuvier. The young animals have a series of small spines on each side of the base of the tail, and a series of spots on each side of the back.

Mr. Gould has brought home two very distinct local varieties.

Var. 1. *Diemensis.* *Young* dark-coloured, with vermiculated marks on the chin, chest, and abdomen. The *adult* dark, beneath gray, varied with black spots placed in irregular lines.

Inhab. Van Diemen's Land.

Var. 2. *Adelaidensis.* *Young* pale above and beneath, with three broad diverging black lines on the chin, leaving an oblong spot in the centre of the throat, with a broad streak on the chest separated into three lines on the abdomen, which unite together again on the pubis. The *adult* gray, with a few spots beneath.

Inhab. Adelaide, Western Australia.

MOLOCH, Grey. Fam. Agamidæ.

Body depressed, covered with irregular unequal, small granular plates, each furnished with a more or less prominent central spine, and with a series of large, conical, convex, acute spines; head and limbs covered with similar scales and spines; head small, with very large spines over each of the eyebrows; tail with irregular rings of large acute spines; femoral and subanal pores none; teeth small, subequal; toes 5. 5, short, covered above and below with keeled scales; claws long, acute.

The external appearance of this Lizard is the most ferocious of any that I know, the horn of the head and the numerous spines on the body giving it a most formidable aspect. The scales of the back are small and unequal; they gradually increase in size as they approach the base of the conical spines, which is surrounded with a ring of larger scales with longer spines: the large spines are conical; rather compressed, spinulose below, smooth and acute at the tip, and are usually furnished with a sharp toothed ridge on the front edge, and sometimes on the hinder one. These spines only consist of a horny sheath placed on a fleshy process of the very same form and appearance as the spines they bear. The scales of the under side of the body are of the same form, and are furnished with similar but smaller and less produced spines than those of the back. The back of the neck of the only two specimens I have seen is furnished with a large rounded protuberance like a cherry, covered with large granular spinous scales, and armed on each side with a large conical spine; but I do not know if this is common to the species or merely accidental in these individuals; at any rate it adds considerably to the singularity of their appearance.

I have named this genus, from its appearance, after "*Moloch*, horrid king."

Moloch horridus. t. v. Pale yellow, marked with dark brown regular spots; sides and beneath black-edged, dark red similar spots.

Inhab. Western Australia. Captain George Grey, Mr. J. Gould.

The marks on the body are very definite, but from the irregularity of their form they are not easily described. The lips are dark brown, with two streaks up to the small spines on the forehead; there is a dark cross-band from the base of the two large horns over the eyebrows, running behind and then dividing into two broad streaks, one along each side of the centre of the back of the neck to between the shoulders, crossing the nuchal swelling. In the middle of the back there is a very large black patch nearly extending from side to side, and over the loins are two oblong longitudinal black spots; the dark lines commencing from the lower angle of each eye extend to the legs, along the upper part of each side to the upper part of the groin. On the front of the fore and hind-legs and the sides are marked similar dark bands. A dark band commences from the hinder part of the lower lip, merging in the throat, and expanding out so as to be united together at the back part of the chin. There is a large, rather oblong spot in the centre of the chest and the hinder part of the abdomen, separated from each by a large, somewhat triangular spot on each side of the middle of the abdomen; body 4½ inches.

This is the Spinous Lizard exhibited by Mr. Gould at the meeting of the Zoological Society, on the 25th day of August, 1840.

Breviceps Gouldii. Smooth, with a few scattered low tubercles; gray-brown, yellowish beneath.

Inhab. Western Australia.

This animal has all the external appearance and character, as far as they are given in MM. Dumeril and Bibron's work, of the *Breviceps gibbosus* of the Cape of Good Hope, except that it has not the yellow dorsal band, and the back is scarcely to be designated as granular. It is the second species of the genus, and only the second Toad found in Australia, the other being *Phreniscus australis*, which I described in the 'Proceedings of the Zoological Society,' under the name of *Bombinator australis*.

UPEROLEIA, Gray. Fam. Ranidæ.

Head large; palate quite toothless; upper jaw with small close teeth;

the tympanum hid under the skin; the toes of the fore and hind-feet elongate, slender, quite free; the ankle with a roundish external and a small conical inner tubercle: the tongue small, oblong, roundish, and entire behind.

This genus is most nearly allied to *Leiuperus* of MM. Dumeril and Bibron, with which it agrees in having no teeth on the palate, but it differs from it in the tympanum being quite hid.

The internal nostrils are some distance in front of the cross-ridge on which the palatine teeth are generally placed.

Uperolia marmorata. Black and green marbled, leaving a triangular greenish spot on the forehead, beneath lead-colour.

Inhab. Western Australia.

Dr. Tschudi has formed a genus under the name of *Crinia*, which appears by his characters to be nearly related to the above; but MM. Dumeril and Bibron (Erp. Gén. viii. 416) observed that the specimens he described have two very small groups of teeth on the vomer.

Hyla bioculata, Gray. Slender; fore-toes quite free; hinder toes webbed to the last joint (in spirits). Grayish white, with a series of very small, indistinct, oblong tubercles, with a dark streak from the nostrils to the shoulder, enclosing the eyes, and a white streak below it from the under side of the eye, sides purplish, with small white spots; back of the thighs purple, with two yellow spots; belly and under side of thighs whitish, granular.

Var. 1. Back of thighs with one or two additional yellow spots.

Var. 2. Back bluish gray; back of the thighs with six or seven small subequal yellow spots.

Inhab. Western Australia.

Hyla Adelaidensis, Gray. Slender; fore-toes quite free, hinder toes webbed to the last joint; (in spirits) gray-blue, with a series of small oblong tubercles; the sides purple-brown, with a white streak from the under side of the eyes to the shoulders; sides of the belly and region of the vent purplish, with small white spots; the hinder side of the thighs purple-brown, with three large oblong white spots; belly and under side of thighs granular; chin white, brownish dotted; palatine teeth in two roundish groups between the internal nostrils.

Inhab. Western Australia.

HELEIOPORUS, Gray. Fam. Ranidæ.

Head short, swollen; eyes large convex; palatine teeth in a straight interrupted ridge between the two internal nostrils; teeth very small; body swollen; skin of the back minutely granular, of the belly smooth; legs rather short; toes 4.5, short, warty beneath, quite free; the hind wrist with a large, oblong, compressed, internal tubercle; the base of the inner finger with a conical wart, ending in a small acute bony process; tongue large, entire behind.

This genus has many of the characters of *Cystignathus*, but differs from it in being warty and swollen, and in having short toes like a Toad.

Heleioporus albo-punctatus. Lead-coloured (in spirits), with white spots; beneath dirty white, with some small white warts at the angle of the mouth; legs smooth.

Inhab. Western Australia.

Cystignathus dorsalis. The palatine teeth in a single large straight line, just behind the inner nostrils; tongue large, slightly nicked behind; the tympanum nearly hid under the skin, gray-brown (in spirits), marbled with dark irregular spots, with a white streak down the middle of the forehead and front of the back; sides pure white, spotted and marbled with black, beneath white; toes elongate, slender, tapering; back part of thighs brown, white speckled.

Inhab. Western Australia. J. Gould.

This species is very distinct from *C. Peronii* and *C. Georgianus*, the two Australian species described by MM. Dumeril and Bibron. It agrees with the former in the disposition of the palatine teeth.

Elaps Gouldii, Gray. Pale yellowish; the scales of the back small, six-sided, with a dark anterior margin, giving the back a netted appearance; top of the head and nape black, with a yellow spot on the rostral scale on each side just before the eyes; head small; the occipital plates large, elongate; the nasal plate triangular; one moderate anterior, and two subequal posterior ocular shields; six upper and lower labial shields, the fourth under the eyes; eyes small, pupil round.

There is an indistinct small yellow spot behind the upper part of the eye; but this may be an accidental variety, as the spots on the two sides are not equally defined.

Inhab. Western Australia.

This species resembles *Calamaria Diadema*, which is also found in Western Australia; but it is larger, and the head is larger in comparison with the body, and in this species it is the base of the scales, while in the latter it is the outer margin that is dark.

Miscellaneous.

Extract from the Proceedings of the Entomological Society, 4th May 1840.

A letter was read from Alexander Burn, Esq., dated Kiva, Gujerat, December 6th, 1839, addressed to the President of the Entomological Society, accompanying a box containing two Indian species of blister-flies which abound at Gujerat, and which he had found to be equal as vesicants to the Spanish fly: indeed when used fresh a *liquor Lyttæ* of greater strength and activity can be obtained from them. The writer had called the attention of the Bombay Government to these insects as objects indigenous to India, which might be worthy of attention as articles of commerce. The first, *Lytta gigas*, Fab., appears early in the season of the monsoon, (August and September), creeping along the ground, seldom using its wings, and feeding on the young tender shoots of grasses. The other species, *Mylabris pustulata*, Blbg. flies about all day, and feeds on the flowers of various plants, specially the esculent *Cucurbitaceæ* and *Hibiscus esculentus* and *cannabinus*, abounding in some seasons to such an extent as to prove extremely destructive to the plants, hardly a single blossom escaping them. To the market gardeners they are therefore a great nuisance, and as the objection to destroy animal life is extremely rank in this part of India, the only plan adopted to get rid of them is picking them with the hand from the plants into large earthen vessels, and sending them to a distance of a mile or two to be set free in any wild or uncultivated spot.

In reference to the above letter Mr. G. Newport stated that he had ascertained that *Meloë Proscarabæus*, the Common English species, was highly diuretic, and it was suggested that as the two species of Indian *Cantharidæ* possessed very powerful medicinal properties and were extremely abundant, it would be advisable that they should be collected in quantities and imported into England, so as to supersede the use of the common blister-fly.*

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* We would strongly recommend this object to the attention of mercantile people in various parts of India, where these flies are common. The supplies of this article which up to within the last eighteen months were imported from Europe, are now obtained in the country for the public service at a saving of several hundred pounds per annum, and it is found that the Native fly is better than the Spanish. These flies are universal throughout India, and may be collected by women and children in any quantity at about one-sixth of the market value of the Spanish fly in England. We would recommend mercantile people who would turn their attention to this object, to consult the Secretary of the Medical Board on the subject, from whom samples of the article, as used in medicine, may be obtained as a guide.—Ed.

List of some of the Articles which have been made at the Futtegurh Flintware Manufactory.

Some thousands of dozens of soda water bottles, vitreous ware, jars from 8 lb. downwards, wide and narrow-mouthed ; mortars and pestles, large and small evaporating dishes ; funnels of sizes, syphons, water and gas pipes, gally pots of sizes, common and with covers, tea pots, butter pots, cups and saucers, jugs and mugs, milk and slop bowls, inkstands double and single, hookah bottoms, candlesticks, flower-holders, chamber utensils ; also fire bricks, fire tiles, glass-house pots, crucibles of sizes, capable of bearing the most intense heat, and glazed tiles for paving 6 and 8 inch ; these latter were intended for forming the floor of a sulphuric acid chamber laid down with a composition of lac and sand, but we ultimately adopted lead ; two of these tiles have lately been sent down through Major Lumsden, C. B., to Colonel Garstin, Superintending Engineer, Lower Provinces.

Futtergurh, 26th March, 1842. W. PYLE.

Indian Turpentine.

We recently received specimens of the resin of Pinus longifolia from Major Carter, as well as from Mr. H. Inglis, Assistant to the Political Agent at Cherra-Ponji. These have been found to yield in the Laboratory of the East India Company's Dispensary 75 per cent. of rosin and ten per cent. of rectified oil of turpentine. This rosin and turpentine are both articles of Materia Medica, the one sold at 10 shillings per cwt. and the other at 80 shillings in the English market, and are exported to India ; where however, whole provinces are overgrown with various species of pines, from which, as the foregoing results show, extensive supplies of these articles might be furnished. All that is necessary in order to obtain rectified oil of turpentine and rosin is a copper still ; the oil distils over, and the rosin remains behind in the still. The oil is rectified by redistillation, a little water being placed with it in the still, the pure rectified oil is collected in a receiver. The only expense attending the production of these articles is the fuel; but if the distillation were performed in the retired places, where the pine forests are so abundant, this would cost but little; so that there is every reason to suppose rosin and turpentine might be produced in India under as many advantages as in America, or elsewhere. They are both articles of common use in the arts, as well as in medicine. It is therefore satisfactory to know that they may be furnished extensively for local consumption, if not as articles of export. Pine forests cover the central ridges of the Kasyah mountains, particularly the northern declivities. Extensive tracts of Kemaon are likewise covered with forests of Pines. In these situations the trees are useless for their timber, but might be rendered productive in the way we have here pointed out.—Ed.

Mineral Indigo.

We received a letter from Major Jenkins the Commissioner of Assam a short time since, enclosing from Mr. Landers, one of his Assistants, a specimen of "*Blue Earth*" found on the banks of the Deko Nuddie, a little above Nagura. The earth consists of deep blue coloured, perfectly fine, and impalpable powder, which gives a blue colour to water and oils with which it is mixed, but the colouring matter appears to be insoluable, and is dissipated and entirely destroyed at a red heat, and protoxide of iron is precipitated from the ashes by hydro-sulphurate of ammonia. It therefore appears to be an earthy substance containing protoxide of iron and vegetable colouring matter. Major Jenkins states that he has written for further information on the subject, requesting to be supplied with large samples, and to be informed if it is procurable in large quantity; as in that case, Major Jenkins suggests it might be used as a paint, if good for nothing else.

In descending the Dhunsiri Major Jenkins himself saw boulders of black clay, which on being broken, proved to consist internally of layers of decayed leaves, which when separated afforded traces of the same kind of coloured earth.—Ed.

Insects at Sea.

We are indebted to Captain Guillamier, the Commander of a French ship, for a species of Casida taken at sea, Lat. 12° N., West Long, 21°. which we find to be near the Cape De Verd Islands; but M. Guillamier, who was struck with the beauty of this insect, states that land was not in view when it came on board. It was captured by M. Guillamier, and lived throughout the voyage to Calcutta, and appeared to be in perfect health when transferred to our charge, after a confinement on board of upwards of three months.—Ed.

OBITUARY.

Late accounts from Europe have brought intelligence of the death of Professor Decandole, Professor Don, and Aylmer Bourke Lambert, Esquire. We were not sufficiently acquainted with these eminent persons, except from a very slight knowledge of their works, to be able to notice the peculiarity of their characters. As biographical notices of them will doubtless appear in the reports of some of the Learned Societies to which they belonged, we shall not fail to notice them in our pages. From Professor Don we had a short time since a kind letter bespeaking an ardent and enthusiastic mind, and from which it will be enough to add the following short extract: "It is gratifying to me," he says, "to witness the efforts of some young and generous minds, to do justice to the memory of Buchanan Hamilton, whose merits as a naturalist were of the highest order; and perhaps no single individual has done so much towards elucidating the riches of the Flora and Fauna of India." Professor Don was a learned Botanist, and held for many years past the office of Librarian to the Linnæan Society, of which he was a fellow. He was also Professor of Botany to King's College, London.

Calcutta, for the Month of January 1842. *Company's Dispensary.*

January. Day of the Month.	Observed at 9 H. 50 M.					Observed at 4 P. M.					Observations Made at 8 P. M.				Observations Made at 10 P. M.			
		Temperature.			Wind.		Temperature.			Wind.		Temperature.				Temperature.		
	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.
	Inches	°	°	°		Inches	°	°	°		Inches	°	°	°	Inches	°	°	°
1	29,858	67,9	68,2	65,5	N. W.	29,794	70,4	75,1	70,0	N.	30,10	70,0	71,0	69,75	30,10	70,0	70,0	69,0
2	,897	69,8	75,5	69,0	N.	,850	73,5	80,0	72,7	N.	,10	70,0	69,5	68,5	,10	70,0	69,0	68,0
3	,913	69,3	75,9	70,0	N. E.	,857	72,8	83,0	76,0	S. E.	,10	71,0	70,5	69,5	,10	71,0	70,0	69,0
4	30,002	69,8	73,8	69,0	N.	,929	74,0	80,7	74,2	N.	,10	71,0	70,0	69,0	,10	70,0	70,0	69,0
5	,037	68,9	72,0	67,2	N. E.	,953	73,2	79,1	71,0	N. E.	,15	71,0	70,75	68,75	,15	70,0	70,0	68,5
6	29,994	67,0	70,0	65,7	N.	,886	71,5	79,1	72,5	N. W.....	,10	71,0	70,0	69,0	,10	71,0	70,0	69,0
7	,950	68,7	75,5	68,5	E....	,882	72,9	81,2	73,1	W.	,15	70,0	71,0	69,0	,15	70,0	71,0	69,0
8	,981	70,0	76,1	69,8	N.	,922	73,0	80,4	72,0	N.	,15	68,0	68,5	67,0	,15	68,0	68,5	68,0
9	30,000	70,0	76,2	68,7	N.	,937	73,2	80,3	71,0	N. W.....	,10	69,0	68,5	68,0	,10	69,0	68,5	68,0
10	,029	69,6	75,2	68,1	N. E.	,954	74,8	82,9	74,2	N.	,10	69,0	68,5	68,0	,10	69,0	68,5	68,0
11	,038	69,0	78,0	70,0	N.	,975	74,4	83,7	74,3	N. W.....	,10	68,0	69,0	68,0	,10	68,0	69,0	68,0
12	,100	70,3	76,5	70,6	N.	,029	74,9	84,2	76,2	W.	,10	68,0	69,0	67,0	,10	68,0	69,0	67,0
13	,039	70,9	76,7	70,5	W.	,954	77,7	86,1	75,8	W.	,10	66,0	67,5	67,0	,10	66,0	67,5	67,0
14	,009	73,5	82,0	73,2	N. W.....	,900	78,2	88,4	78,2	N. W.....	,25	65,5	67,0	66,0	,25	65,0	67,5	66,0
15	29,970	74,5	82,4	73,3	N.	,900	79,0	88,0	78,3	N. W.....	,20	65,0	66,0	65,0	,20	65,0	66,0	66,0
16	,989	74,9	82,1	73,8	N.	,932	78,8	86,0	79,0	N. W.....	,20	65,0	66,0	65,0	,20	66,0	68,0	66,75
17	30,090	72,5	74,4	68,7	N.	,982	77,4	83,9	75,1	N.	,25	65,0	65,0	65,0	,25	65,0	66,0	65,5
18	,022	71,5	74,3	66,0	N.	,948	75,9	81,1	72,2	N. W.....	,20	66,0	68,0	66,5	,20	66,0	68,0	66,5
19	,009	70,2	76,1	67,5	N.	,929	75,8	83,4	72,1	N. W.....	,15	66,0	66,5	66,0	,15	66,0	66,5	66,0
20	29,994	70,2	76,1	69,2	N. E.	,910	75,5	83,9	74,1	N. W.....	,15	66,0	66,5	65,75	,15	66,0	66,5	66,0
21	,997	71,4	76,0	68,1	W.	,885	76,9	85,2	74,3	N. W.....	,15	67,0	68,0	67,0	,15	67,0	68,0	67,0
22	,909	71,0	75,0	69,8	N. W.....	,841	77,3	89,5	77,8	N. W.....	,20	68,0	68,0	67,0	,20	68,0	69,0	68,0
23	,910	74,3	78,2	70,0	N.	,837	77,9	85,2	74,3	N. W.....	,15	68,0	67,75	66,75	,15	68,0	67,75	67,0
24	,985	69,2	71,5	62,4	N. (Sharp)	,882	74,3	81,8	69,9	N. W.....	,10	68,0	68,0	67,0	,10	68,0	68,0	67,0
25	,950	69,4	72,2	64,0	N.	,857	74,0	83,8	73,7	N. W.....	,10	67,5	68,0	67,0	,10	68,0	68,0	67,0
26	,926	69,5	74,8	65,5	N.	,858	74,9	81,4	69,0	W. S. W.	,15	67,75	68,75	67,0	,15	68,75	68,75	67,0
27	,889	70,9	72,0	70,7	N. E.	,797	79,4	84,5	76,1	S. W.	,15	68,0	68,0	66,75	,15	68,0	68,0	66,5
28	,866	72,9	74,0	70,5	N.	,813	77,2	84,6	73,5	N.	,20	68,0	68,0	67,0	,20	68,0	68,0	67,0
29	,946	70,5	73,9	64,0	N. E.	,893	74,7	82,2	70,6	N.	,15	68,0	67,5	66,5	,15	68,0	67,5	66,75
30	30,025	70,9	76,5	66,0	N. E.	,946	74,1	85,0	72,5	E.	,15	68,0	67,5	66,5	,15	68,0	68,0	67,0
31	,025	68,8	74,2	65,8	N. E.	,949	73,4	82,2	71,8	W.	,15	68,0	68,0	67,0	,15	68,0	68,0	67,0
Mean.	29,976	70,6	75,3	68,4		29,952	75,2	83,1	73,7									

N. B. From a comparison of the two Barometers, the Mercury in the one at the Dispensary stands 1-10th of an inch higher than in the one in use at the Surveyor General's Office.

Meteorological Register kept at the Surveyor General's Office, Calcutta, for the Month of February 1842.

The Observations after Sunset are made at the Hon'ble Company's Dispensary.

	Observed at 9 H. 50 M.					Observed at 4 P. M.					Rain Gauges.		Observations made at 8 P. M.				Observations made 10 P. M.			
		Temperature.			Wind.		Temperature.			Wind.				Temperature.				Temperature.		
February. Day of the month.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.
	Inches	°	°	°		Inches	°	°	°		Inches	Inches	Inches	°	°	°	Inches	°	°	°
1	30,050	66,1	72,3	64,0	N. E.	29,954	72,7	80,0	70,0	W. ..			30,20	69,0	68,5	67,75	30,20	69,0	68,0	67,0
2	,022	68,7	74,6	66,4	N. E.	,930	74,5	85,8	73,9	N. W.			,15	68,75	68,0	67,0	,15	69,0	68,0	67,0
3	,002	69,8	77,3	68,0	N. E.	,905	75,0	88,0	76,2	N. W.			,10	72,5	72,0	70,75	,10	72,0	72,0	70,5
4	29,961	69,7	77,5	69,0	N. E.	,894	74,2	82,0	72,7	N. W.			,10	73,0	72,0	71,0	,10	73,0	72,0	71,0
5	,941	74,0	80,2	74,1	S. ..	,838	79,0	89,5	78,9	W. ..			,05	75,0	74,0	73,0	,05	75,0	73,75	73,0
6	,953	74,9	78,2	75,0	W. ..	,881	79,4	88,5	78,0	w.s.w.			,10	75,0	74,0	73,0	,10	75,0	74,0	72,75
7	30,033	73,9	77,5	68,8	N. ..	,961	77,9	85,7	74,0	N. ..			,15	75,0	74,5	73,75	,20	75,0	74,0	73,5
8	,086	70,5	72,9	63,0	N. ..	,954	76,0	85,0	74,0	N. ..			,15	74,0	74,0	73,0	,15	74,0	74,0	73,0
9	,074	71,5	75,5	65,5	N. E.	,973	75,5	82,0	70,0	W. ..			,15	74,0	74,0	73,0	,15	74,0	74,0	73,0
10	,045	70,0	76,3	67,5	N ..	,930	75,6	88,0	75,0	N. ..			,15	73,0	73,0	72,0	,15	73,0	73,0	72,5
11	,037	72,0	77,5	73,0	N. W.	,926	77,2	88,5	77,2	w.s.w.			,10	75,0	74,0	72,75	,10	75,0	74,0	72,75
12	29,954	75,3	80,2	74,7	S. ..	,857	82,0	89,8	80,2	S. ..			,10	75,0	74,5	72,5	,15	75,0	74,0	72,75
13	,986	75,1	83,1	75,0	E. ..	,870	80,0	92,0	80,0	N. W.			,15	76,0	75,0	73,75	,15	76,0	75,0	73,75
14	,934	76,0	81,8	71,0	N. W.	,842	81,8	90,8	76,7	W. ..			,15	77,0	78,0	76,5	,10	77,0	78,0	76,5
15	,902	77,0	81,5	75,0	W. ..	,810	84,1	92,7	77,5	W. ..			,10	79,0	80,0	79,0	,10	79,0	80,0	79,0
16	,884	79,6	86,2	77,9	W. ..	,810	85,1	97,0	82,0	W. ..			,10	80,0	80,0	79,0	,10	80,0	80,0	79,0
17	,898	79,4	86,0	75,8	W. ..	,817	85,8	98,4	81,9	w.s.w.			,00	82,0	81,5	80,0	,00	82,0	81,75	80,0
18	,908	79,7	86,0	75,8	N. W.	,838	86,0	99,4	79,8	W. ..			,05	81,0	80,0	79,0	,05	81,0	80,0	79,0
19	,958	79,2	82,2	69,0	N. W.	,862	85,5	94,2	78,0	N. W.			,05	81,0	81,0	79,5	,05	81,0	81,0	79,75
20	,906	75,2	79,0	67,0	N. ..	,825	81,0	88,0	72,0	N. W.			,10	81,0	80,0	79,0	,10	81,0	80,0	79,0
21	,938	74,2	78,2	66,3	N. ..	,813	78,8	83,5	69,3	W. ..			,10	80,0	80,0	78,75	,10	80,0	80,0	78,75
22	,909	73,8	80,7	72,5	N. E.	,809	80,0	87,8	76,2	S. W.			,10	80,0	81,0	79,5	,10	80,0	81,0	79,5
23	,906	77,0	82,0	76,2	S. ..	,812	82,4	86,0	77,9	S. E.			,05	79,0	78,0	76,75	,05	79,0	78,0	76,75
24	,854	79,4	82,6	77,0	S. ..	,738	83,2	86,2	78,5	S. ..			29,90	80,0	79,5	78,0	29,90	80,0	79,0	78,0
25	,826	78,2	82,0	76,8	S. W.	,750	82,9	89,8	78,0	N. W.			,95	81,0	80,75	78,75	,95	81,0	80,0	79,0
26	,826	79,3	80,9	77,0	S. ...	,742	81,6	87,9	80,0	S.s.w.			,90	81,0	81,0	80,0	,90	81,0	80,75	80,0
27	,778	78,5	80,5	76,1	SSW.	,709	88,0	97,0	81,0	S·s.w.			,95	80,0	80,0	78,75	,90	80,0	79,75	78,0
28	,774	80,2	87,0	79,0	S. W.	,706	91,2	97,0	80,6	S. ..			,90	82,0	81,75	86,0	,90	82,0	81,0	79,75
Mean.	29.940	74,9	80,0	72,0		29,848	80,7	89,3	76,8		0	0								

N. B. From a comparison of the two Barometers, the Mercury in that at the Dispensary stands 1-10th of an inch higher than that in use at the Surveyor General's Office.

THE
CALCUTTA JOURNAL
OF
NATURAL HISTORY.

On East Indian Isinglass, its introduction to, and manufacture for, the European Market. By the EDITOR.

Having called attention to the subject in the March Number of the *Journal of the Asiatic Society* for 1839, p. 203, and again in the *Researches of the Asiatic Society*, for October of the same year, it was our intention to remain silent regarding Bengal Isinglass, with the view of allowing the article to work its own way in the English market.

But the appearance by the January mail of the proof sheets of a pamphlet by Dr. Royle on this subject, renders a few observations necessary, in order that the information before the Government may be as complete as the results which have been ascertained are capable of making it.*

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* Dr. Royle's valuable Report on this subject has been reprinted in full in our last number, together with additional notes of our own.

Dr. Royle's pamphlet comprises all the information he has been able to collect in his office at the India House, as well as the opinions of brokers, dealers, and consumers, as to the defects of the Bengal compared with the Russian Isinglass. It also contains, what was very much desired, a detailed chemical analysis of the Bengal article, all which will be of service to those who are engaged in preparing Isinglass in this country.

Much information has, however, been collected in India, that has not been officially reported to the Government, nor published ; and some also has been published in the two last numbers of the *Calcutta Journal of Natural History*,* which Doctor Royle could not have been aware of when he wrote; so far therefore his pamphlet is deficient, and it is to supply this deficiency that we now enter upon the subject.

Having found, in December 1839, that notwithstanding the publication in Calcutta of several statements in which the advantages of making Isinglass from fishes in the Hoogly were pointed out, still we found that no one had taken up the article with a view to the European market, and the little that was collected by the fishermen, was purchased, as usual, by the Chinese in a rough state, with as little competition as if nothing whatever had been published on the subject.

Such being the case, we felt that it would be altogether waste of time to write more about it, and instead of doing so, we desired our servants to collect the article from the fishermen, the same as the Chinese were doing, and at the same rate, or a slight advance if necessary. In the course of about a month, by going from village to village along the banks of the Hoogly and Salt-water lake, our *khitmutgar* collected altogether about 45 maunds.

A maund consists of about 200 impure dry fish bladders,

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* Nos. 7 and 8 for 1841, pp. 450, 615.

and the rate charged for these was 4 rupees per score, or 40 rupees per maund. It was necessary to buy them by the score, because it seldom happened, that so many as a maund could be had at any one place. In the hands of petty dealers, who collected from the fishermen for the Chinese, three or four maunds were occasionally met with; but as far as we have been able to learn, there is every reason to doubt the accuracy of Mr. Remfrey's statement, quoted by Dr. Royle, page 32, in his pamphlet, that in one village on the Salt-water lake, the Chinese obtain from 800 to 900 maunds for the Chinese market.

On the contrary, we think the transactions of the Chinese in this article in the vicinity of Calcutta has been extremely small; for although we advanced a higher rate for the article than the Chinese ever gave, in order to secure all, or as much as was collected, with a view to ascertain the extent of the trade, yet we only succeeded in obtaining 45 maunds the first year, and the following year, 1840-41, at the still further advanced rate of 50 to 55 rupees a maund, we only succeeded in obtaining 75 maunds.

We are therefore led to the conclusion, that so far from finding supplies ready to our hands in any one place, to the extent stated by Mr. Remfrey, we must look for large supplies of the article in the improvement not only of the demand, but also of the means, which European capital and intelligence can alone supply.

We commenced collecting Isinglass in December 1839, then nearly the end of the season, only because we found the object neglected. Had we not taken this step, on finding no one else disposed to set the example, we are strongly impressed with the conviction, that Bengal Isinglass would still be unknown as an article of import in the English market.

The following is the upshot of the first year's operations, which, if viewed merely as a mercantile speculation, must be regarded as a decided failure, as it has left us upwards of 2,000 rupees out of pocket.* If, on the other hand, it be regarded as an experiment, by which the value of an article unknown before in the European market was to be tried, we think it has been eminently successful, and must lead to permanently useful and beneficial results.

Those who have purchased the first investment at 1*s.* 7*d.* per lb. in 1840, appear to think "that 3*s.* 6*d.* per lb. is nearer the price that it would now (1841) bring." No process of mere reasoning or of argument, however conclusive, could have led to this result. Nothing, in short, but an extensive trial of the article, such as that which has been afforded at our expence, could have demonstrated the value of East Indian Isinglass, to the satisfaction of brokers and consumers.

There was no other way in which that trial could have been made, but by taking its responsibility entirely upon ourselves. We felt assured, that an application for an advance of public money for such an object would not be attended to, and even if it could, that we could not make it; on the other hand, we felt perfectly satisfied as to the importance of the object, and that there was no other way in which the experiment could be made than by taking it solely upon ourselves.

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* It will be seen by the annexed extracts from correspondence with the Government that this sum has been liberally reimbursed to us.—Ed.

ISINGLASS ACCOUNT 1839, 1840. Cr.

1839.	CALCUTTA.				
Dec.	Advances paid by myself to Fishermen for 8,825 fish maws, at 4 Rs. a core, (about 40 Rs. a Maund.)	1,750	0	0	
1840. Jan. 8	Paid to coolies and for petty charges and cleaning or converting them into Isinglass...	100	0	0	
,,	Paid to Messrs. Cantor and Co. for 5 chests lined with tin for packing Isinglass....	30	8	0	
,,	Paid for 30 ditto, made to order in the bazar.	123	12	0	
Feb. 5	Paid to my Agent Messrs. Cantor and Co. for insurance and sundry charges of 35 chests of Isinglass per *John Colvin* as per their Ac. Cur. with me.	756	0	0	
Mar. 14	Paid to ditto for Shipping charge and Export duty on 35 cases of Isinglass per *John Colvin* as per Account Current.	163	13	0	
,,	Paid to do. for damering and coopering 35 chests of Isinglass.	24	6	0	
		2,948	7	0	
	To Interest from Dec. 1839 to Feb. 1841, being 1 year 2 mths. for 2,948 : 7 : 0 at 4 per Ct....	137	9	6	
	Co's. Rs.	3,086	0	6	
	£				321 5 1

(Signed) J. M'CLELLAND.

Lot J. M. 4—10.	By an account of sale of above Isinglass per *John Colvin* sold at public sale 2d. Nov. 1840. 35 Cases weighing net 2,235lbs. at 1*s.* 7*d.* per lb.				176 18 9
	CHARGES.				
Dec. 5	Freight from Calcutta, ...	32	0	0	
	Interest on ditto to prompt, ...	0	5	5	
	Fire Insurance, on £ 1000 at 2*s.* 6*d.* per Cent.	1	5	0	
	Marine Insurance from Calcutta, ...	27	1	8	
	Import rate and Ware House rent, ...	4	15	1	
	Warehousing entry, ...	0	4	6	
	Fee to officer, and amending entry, ...	0	17	6	
	Advertising and printing Catalogues	1	1	0	
	Receipt, stamps, and petty charges.	0	5	0	
	Brokerage 1 per Cent.	1	15	4	
	Commission 2½ per Cent. ...	4	8	0	
					73 18 10
	£				102 19 11

LONDON.
31*st.* *December*, 1840.

(Signed) J. COCKBURN & Co.

From 14th March 1840, when we transferred the article to our agents, Messrs. Cantor and Co., we left every thing connected with its shipment and sale on our account to that firm. It is due, however, to the liberality of H. M. Low, Esq. one of the partners in the late firm, to say, that he offered to take the risk of the investment on himself, and to repay to us the 3,086 : 6 : 0 Rs. which it had then cost us. This very kind and liberal offer of Mr. Low, we considered it our duty to decline. The experiment was undertaken with a public view, and any private arrangement, such as that proposed, we conceived might alter the character of the transaction, as far as we were individually concerned.

The sample of Isinglass therefore which Dr. Royle states, page 31 in his pamphlet, to have been the first received at the India House, and which was sent to him on the 30th October 1840, by Mr. Cantor, with a note, stating that it was a specimen of a consignment sent by his house in Calcutta, belonged to, and formed a part of that which was prepared by us, and sent at our own expence and risk through Messrs. Cantor and Co., to the London market for trial, consisting as already stated, of 2,235 lbs.

Whether the specimens subsequently presented by Messrs. Rogers and Remfrey, and alluded to, page 31, in Dr. Royle's pamphlet were derived from our stock, is of little consequence, as the public sale at which the 2,235 lbs. were disposed off, took place on the 2nd of November, only three days aftér the first specimen had been received at the India House.

We have been thus particular in stating the circumstances and views under which the first investment of Isinglass sent from India to the European market was made, because we regard the subject of very great importance, and are desirous of placing the facts connected with it in as clear a light as possible.

The only other person besides ourselves, who took any practical interest in the subject during the season of 1839-40, was Mr. G. T. F. Speed, who after our own operations had created a stir amongst the fishermen, appeared for the first time to have entered the market, if we might so express it, as our rival; but whether Mr. Speed's experiment was of such dimensions as to create any very serious impression in the Home market, or to produce satisfactory and conclusive results, or whether it would ever have been undertaken but for our example, we cannot take upon ourselves to say. Thus much, however, we have much pleasure in stating, that Mr. Speed was, in our opinion, perfectly successful in rendering his Isinglass as pure and free from fishy smell, and in every way as neat, as Russian Isinglass.

The opinions of brewers and brokers as to the quality of the first investment were so unfavourable, that had they not been in some respects directly opposed to what we had ascertained before hand to be the properties of the article, as well as contradictory among themselves, we should have been disposed to abandon all hopes of the article.

In October and November 1839, we were employed in an investigation of different kinds of fishes yielding Isinglass in the Hoogly, as well as the properties of the article as afforded by different fishes. The following are the results as regards the latter part of the subject:—

Sort of Fish.	*Per cent. Gelatine.*	*Per cent. Albumen.*	*Quantity tried of each.*
Large Suleah, ...	93.4	6.6	100 parts.
Small Suleah, ...	86.7	13.3	100 ,,
Small Bola, ...	87.0	13.0	100 ,,
Small Silurus Rita, ...	67.0	33.0	100 ,,

From the above results we were satisfied, that the complaints of the brokers and brewers of the large size, thickness, &c. of the Indian Isinglass resulted from prejudice;

as the largest and thickest sounds, or those of full grown adult fishes, seemed to be the purest Isinglass. We are aware of the *bulky* appearance of the little albumen contained in the large Sulea Isinglass, but if this be collected on a strainer and dried, it will be found to amount to no more than 6 per cent., 94 per cent. nearly, being pure gelatine which is entirely soluble, yet the large Sulea Isinglass was declared by some to be *insoluble.* In small Sulea and other smaller fishes, the results were more unfavourable.

Others protested against the smell, which they declared to be peculiarly offensive. Our Isinglass, after eight or ten day's exposure only to the sun and dew, had lost completely its fishy smell before it was packed; it is probable, however, that it had been packed too fresh, and that the packages may have got damp on board ship, or perhaps in the Custom-house or other stores at home; in that case the smell would be very offensive, but the article might still be perfectly freed from smell again by re-exposure for a time to dry air. We cannot exhort merchants and others too much as to the importance of having Isinglass perfectly dry when packed, and well aired when offered for sale.

We would therefore recommend exposure to the open air for months before packing, and that the packages should be small, not exceeding ten lbs. each. Our packages were large chests of eighteen cubic feet each, and from which the article ought to have been removed and well aired in London before offering it, either as samples or for sale. The package of the article during so long a voyage is a subject of much importance.

We cannot take upon ourselves to say how far the article may have been injured after it left our hands by exposure to a hot sun in the month of March, when passing the Custom-house, and other forms prior to shipment, or what injury it may have sustained from damp or other causes on board ship, or in the docks and stores in London.

We are of opinion, that small gunny, or coarse canvass bags would be the safest and best package, but on this subject experience will be the best guide. Doctor Royle has omitted to point out how the Russian Isinglass is packed, and to consult the brokers on the best methods of packing the Indian article. The great fault complained of was the smell, a fault which it must have acquired after it was packed, and had left our hands, and which the lapse of time during the voyage could not account for. In March 1840, we had about 15 or 20 seers of the article left, which was not enough to make an uniform package. It was therefore allowed to lie, during the ensuing rains, neglected in a damp cellar until the November following, when the complaints of the brokers arrived regarding the smell of the despatch sent home for sale.

But so far was this neglected sample from having contracted any bad smell, that it had on the contrary lost *every trace* of that which it originally possessed, a fact to which we cannot attach too much importance. The greater size of the packages, and their closeness from having been soldered, and exposure to sun in this state during shipment, or to wet on board ship, or to rain in England, are the only causes to which we can ascribe the smell complained of in the investment sent home; but we are perfectly satisfied that the fishy smell of Isinglass may be altogether removed by continued exposure to the air; this may be as well effected in Europe after removal from the original packages as in India. But if this be considered an injury to the article in the European market, it will only be necessary for those who are engaged in its preparation in India, to adopt more precaution for its perfect removal, by care in cleaning in the first instance, and subsequent airing before packing, as well as by attention to the description of package.

The arrangements for future operations in this article were shaped according to the advices received from Messrs.

James Cockburn and Co., relative to the above experimental investment, due allowance being made for the prejudice of brokers and consumers. Their first letter on this subject is dated 4th May 1840, in which they say, "Isinglass advised is a new article from your quarter. We shall have great pleasure in doing all in our power to have it well shewn, and to obtain the highest value for it, as we cannot but feel an interest in the introduction of a new article of import." In their second letter, dated 31st October 1840, they enclose the opinion of different brewers as to its value.

Truman, Hanbury, Buxton and Co. state, that the sample submitted to them was not *sweet*, and that if it were so, it would be worth 3*s.* to 4*s.* 6*d.* per lb. if it yielded well in testing, but they add, Isinglass is a very difficult article to judge of by appearance only. Messrs. Cockburn and Co. therefore enjoin greater care in cleaning, and state, that if put up in the manner of Russian Isinglass, it would command at least 4*s.* to 5*s.* per lb., and they enclosed in their letter a piece of Russian Isinglass worth 12*s.* per lb. to which our own appeared in every respect equal in quality. The only difference appeared to be in size; the Russian staple weighed only about an ounce, while the Indian varies from six to fourteen ounces, the produce of each fish being so much in favour of the latter; the nature and properties, texture, and structure of both being economically and chemically the same.

The third letter of Messrs. Cockburn and Co. to their correspondents in Calcutta, is dated 4th November 1840, two days after the public sale. They state, that they had taken considerable pains to have the Isinglass well shewn, and to obtain the best opinion of its value, and also the probable quantity that could be safely sent to the London market.

"The first point," they say, "for your friend," (alluding to us,) "to consider, is to make it up in a state for consumption, which should be done by carefully cleaning the bladders as soon as they are taken out of the fishes, scraping off all fat and fleshy or skinny particles, and to get off entirely the ***thin skin*** in the inside of the bladders, wash them carefully in fresh water, and then dry them in the sun.

"When the process is complete, they will be of one uniform colour, clear, and transparent, and free from all fishy smell, and *if they arrive* in this state, they will probably sell for as much as 5*s*. per lb., but we think you may safely calculate upon getting 3*s*. 6*d*. for any quantity up to 50 or 60 tons in the course of the year. If, however, they are very successful in bleaching, a larger quantity may be sent. It is stated to be a description of glass only suited to brewers, who take Brazil Isinglass chiefly for their use, which is now worth 2*s*. to 3*s*. 6*d*. per lb. This glass leaves a large residium when melted, unless mixed with an acid which renders it of no value, except for brewers, otherwise it would command a higher value."—*Letter of Messrs. J. Cockburn and Co.*

We have now to notice how the operations thus commenced have been followed up. In the months of August and September, the fishermen represented the necessity of making advances to them before November, the season when Sulea fishing commences, in order that they might be enabled to make preparation for taking the largest possible quantity of fish. Their representations appeared perfectly fair and reasonable, and we conceived it to be highly desirable to know what quantity of fish could be procured under the arrangements they proposed.

The results of the sale of the last investment were however still unknown, so that advances could not be made with safety to the extent that was necessary; some seven or eight hundred rupees were, however, given out in small sums for the construction of nets, boats, &c. to some forty or fifty villages, and about the end of November the article began to come in, and continued to arrive in the proportion of from one to three maunds a day for about six weeks, when we found the whole amount furnished did not exceed 75 maunds, although the prices rose in consequence of competition towards the end of January to 50 and 55 rupees per maund.

The advices from England having arrived, the next object was to improve the manufacture, and as pointed out in Messrs. Cockburn's letter of 4th November 1840, to make up the article in a state for home consumption. Our intercourse being now fairly established with all "*interests* in *the trade*," we became acquainted with a family who had been in the habit of accompanying the fishermen for the purpose of obtaining fresh fish sounds, which they pull out into shreds in imitation of the European form of Isinglass as described by Mr. Remfrey, page 32, in Dr. Royle's pamphlet, a form that appeared to be admirably suited to the English market.

Our fish sounds were, however, dry and hard, so that it became necessary to bring them back to their original soft state before they could be converted into the shredded state. With this view, they were soaked in lime water for twelve hours, and cleaned in the same manner as the Isinglass of the first year 1839-40; in addition to this treatment, they were next steeped in alum water a short time, and then spread out on cotton clothes, also saturated with the same, and rolled tightly up in the folds of the cloth, and left overnight covered to prevent evaporation; on opening the damp cloths the following morning, the fish sounds were found perfectly soft, as in the first instance when removed from the fish, and such parts as were cleaned properly quite white. In this state the Isinglass may be either pulled out into shreds, or pressed as thin and flat as is desired, by passing it between double rollers. After the manipulation is completed, and the article is reduced to the form intended, a little fine chalk is to be dusted over it, which prevents the soft pieces from adhering to each other. This if found at all injurious, may be avoided by spreading the fresh Isinglass on cloths to dry at once, when the chalk would be unnecessary. The only thing necessary to be guarded against in using the chalk is, that when it is once applied to the Isinglass, we cannot attempt to alter the form of the latter by further pressure or manipulation, otherwise we press the chalk into the soft surface, or even into the substance of the Isinglass, from which we cannot afterwards remove it by any subsequent process; it thus destroys the transparency and natural appearance of the article, without however any injury to its properties; for, as Dr. Royle remarks, the chalk will subside in solution.

The greater part of the Isinglass we prepared during the second year was in the shredded form, the rest was passed between rollers. The first is the most expensive mode of preparation. We had the shredding part of the process done on contract at eight annas per seer.

The sample submitted to Government, 17th February 1841, for transmission to the Honorable Court of Directors, consisting of 28 seers, both of the rolled and shredded sort, and subsequently, as suggested in the letter of Government, General Department, No. 324, under date 24th February, a second chest consisting of 33 seers of the shredded Isinglass was also submitted, for transmission to the India House. In all 61 seers, instead of 46,* as stated by Dr. Royle, page 33, had been thus forwarded at the request of Lord Auckland, who evinced much interest in the subject. His Lordship, however, conceived that it might be objectionable to allow a servant of Government to enter upon experiments partaking so much of the character of speculations, upon which we transferred our interest in the second year's ope-

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* *Calcutta Journal of Natural History*, 1842, page 93.

rations in the article to Messrs. Cantor and Co., continuing however, to conduct the experiment as if it were still on our own account, until all the article on hand, consisting of 47 chests of Isinglass, exclusive of the two chests presented to Government, were completed, the whole amounting to about 50 maunds of 80 lbs. each.

The outlay, exclusive of interest, insurance, and shipping charges for this quantity was 6000 rupees, including the cost of the impure article as extracted from the fish at the advanced rate of 40 to 55 rupees per maund;* also package, the erection of a shed, and the additional charge of 8 annas a seer for shredding nearly two-thirds of the whole quantity, which last item might have been saved had we known the prejudice in the English wholesale market, (referred to p. 36, Royle's pamphlet,†) against things in a powdered or cut state. Yet under all the disadvantages of having to feel our way here in the manufacture of a new article, and our ignorance of the form best suited to the market at home, the outlay in India, including all expenses, amounted to no more than 120 rupees per maund, or 1/8 per lb., and unless the objection to the shredded form operates unfavourably in the wholesale market, the article will fetch 3*s.* 6*d.* per lb. Mr. Cantor, one of the members of the firm to which the article was transferred, and who being himself in London at the time of its arrival, commenced disposing of it to retail dealers at 3*s.* 6*d.*, but after the failure of the house, the assignees will not perhaps take the same interest in the article, and the brokers in the wholesale market will thus be able once more to obtain it at their own terms. The 4000 lbs. of which this investment consisted, (including the two chests forwarded to the India House,) together with the 2235 lbs. of the preceding

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* It is procured at Arrakan and Moulmein at 30 rupees, and if extensive means were employed, might be had for still less; vide *Calcutta Journal of Natural History*, 1841, pp. 452, 614.

† *Calcutta Journal of Natural History*, 1842, p. 95.

year, the whole of which we collected and prepared, amounting nearly to three tons, will render the article well known, and tend to establish its value in a way most likely to remove all difficulties and uncertainty in future operations in regard to it.

In describing the article, page 35 in his pamphlet, Dr. Royle describes the samples he received from Messrs. Cantor and Rogers, as of a different kind from what he received from us. We can explain this by stating, that Messrs. Cantor and Rogers' specimens were merely samples from our own first investment, consisting of the fish sounds simply split open, the external and internal membranes removed, and the air vessels washed and dried. These specimens are described by Dr. Royle as of "oval shape, nine inches in length, and five in breadth, and at least a quarter of an inch thick; *opaque*, of a brownish colour externally, but beautifully white, even silky-looking when thin pieces are stripped off. These specimens," Dr. Royle states, "had neither taste nor smell, but as they were only few in number, the *smell could not be judged so well as when in bulk.*" We have placed in italics, such parts of this description as we think wrong. These specimens were, or ought to have been translucent when held against the light; but strips removed from the mass are opaque, as well as the mass itself, when either surface is broken.

Secondly, we think it would be wrong to imply that the true way of judging of the smell is in *bulk*, merely because the article has been sent home in bulky packages of eighteen cubic feet; for if this be found to cause the article to smell, the packages may be made as small as we like, and it is quite enough to know, that when the bulk is separated, as it must be before the article can be used, it loses its smell like the samples presented to Dr. Royle by Messrs. Cantor and Rogers. We have dwelt on this point as one of vital consequence; the samples in question having been mere average specimens of an investment of 2235 lbs., which was sold at a loss, because it was said to smell.

Dr. Royle next describes the samples which we sent through the Government to the India House, which he says, " are from six to twenty-four inches long, and about three or four inches broad, and from 1-6th to 1-10th of an inch thick, white in colour, rough in some places, apparently from adhering portions of membrane stripped off; smooth and translucent in others, and occasionally nearly transparent in some, &c." One would suppose this to be quite a different article from that which was presented by Messrs. Cantor and Rogers from our first year's manufacture, but its peculiarities depend on the oval substance (or air-bladder) having been divided and drawn out, when soft, between rollers, and subsequently dusted over on the surface with lime, a mode of preparation which we did not employ in the samples presented by Messrs. Cantor and Rogers.

Having now explained what has been done in the manufacture of Isinglass, particularly by ourselves, we turn with more satisfaction to what has been accomplished by others, as far as we are in possession of information on this important subject. J. G. Malcolmson, Esq. of the firm of Forbes and Co., Bombay, in a note to our address dated 25th March 1841, states, " I have already prepared Isinglass here of course from your (meaning the Calcutta) " Polynemus," and from a fish with large scales." Soon after the receipt of Mr. Malcolmson's note, we were favoured by Sir James Carnac on his departure from Bombay, with information collected there by Dr. Heddle at the request of Lord Auckland. The substance of which is, that the article known in commerce as *Fish Maws*, is the swimming bladder of a species of fish, which attains 2½ to 3 feet in length, and is very common, at certain seasons, all along the coast.

This fish, of which Dr. Heddle has been kind enough to send a specimen, proves to be the same as our Bengal species, and is in fact *Polynemus Sele*, Buch. Dr. Heddle states, that at Bombay this fish is called *Dara;* at Scinde, (where it proves, as originally suggested by us, to be the source of the cod sounds alluded to as an article of export from Kurachee) it is called *Seer.*[*] The substance extracted from the *Dara*, as well as two other species on the Bombay coast, which we shall presently notice, is called *B'hāt* by the Mahrattas, and *P'hāt* by the Guzeratees and Scindees. *B'hāt* is collected by the fishermen, and sold to a certain class of Mussulman merchants, called *Khojah*, who export it largely to China.

The principal portion of the *B'hāt* exported is collected, Dr. Heddle states, from the *Dara;* the best is from Scinde, and sells for 20 to 25 rupees per maund. This fish Dr. Heddle states, frequents the whole of the western coasts of India, particularly the coasts of Scinde, where it penetrates up the estuaries of the Indus, and is caught at Gorabari, Kurachee, and other places on the estuaries of the Indus. *Polynemus Sele*, or *Dara*, appears from the statement of Dr. Heddle to afford the best *B'hāt*, or fish sounds, as well as the largest supplies. The fish itself is also highly esteemed as an article of food.

The second kind of fish affording this article, attains, according to Dr. Heddle, four feet in length, the usual size is from 2½ to 3 feet, and is caught in great abundance about Bombay, the flesh of which is reckoned wholesome by the

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[*] We were not unprepared for the confirmation of this important fact, as the species was found by Bruce, the African traveller, to frequent the coasts of the Red Sea, although as Cuvier remarks, "par une de ces étourderies dont son livre est rempli, il ecrit au bas de la planche le nom de *binny*, et il lui applique dans son texte tout ce qu' il avoit recueilli sur le vrai *binny*, qui est un poisson du Nil, du genre des barbeaux (le *Cyprinus binny*, Forsk et Gmel.) Il n'y a point de Polyneme dans le Nil, et c'est uniquement sur cette mèprise de Bruce qu'est fondée l'espéce du *Polynemus Niloticus* du Shaw."—*Hist Nat. des Poissons*, t. 3. p. 283.

natives, and is very generally found in the Bazars with the air bladders extracted, having been previously removed by the fishermen, who sell them in a fresh state to the *Khojah* or *B'hāt* merchants, who dry them for exportation. The name of this fish, both at Bombay and Scinde, is *Gol.* We have also been indebted to Dr. Heddle for a specimen of this fish, which we identify as a species of *Bola,* indicated by Buchanan as a variety of his *Bola Chaptis,* called *Naria* in Jessore. It will be recollected, that we identified this same species as the *Not-kadon* of the Burmese, and one of those recently sent to the Government as yielding Isinglass on the Tenasserim Coast, (*Calcutta Journal of Natural History,* vol. ii, p. 454,) and now we find it contributing largely to commerce, as well as to the common food of the people of the Malabar Coast.

Although indicated by the accurate Buchanan, this species has never been described; it belongs to the genus *Corvinus,* Cuv. The specimen received from the Tenasserim Coast, as well as that from Bombay, were too large and too much decayed to allow of detailed descriptions being made from them; nor is the drawing with which we have been favoured by Dr. Heddle, sufficiently characteristic in regard to details, otherwise we should be glad to give it publicity.

It may be sufficient, however, for the present to say, that the species is very closely allied to *Corvinus Niger,* Cuv. but of monstrous dimensions compared to the European species. From the account given of it in Dr. Heddle's letter under the local name of *Gol,* as well as from its occurrence on the Tenasserim Coast, as already pointed out, and also in the Gangetic estuaries, this species, together with the Isinglass it affords, ought to be carefully examined and investigated.

Dr. Heddle in the same letter mentions, that there is still a third species on the Bombay Coast which affords Isinglass, called *Kota,* of which he has kindly promised to forward a specimen to us, as well as of another fish of which Caviare is prepared.

Of these fishes, which at Bombay contribute largely to the exports of that place, two have within the last few months been made known as common also on the Tenasserim Coast, where their value, as far as we yet know, appears to be less, or indeed little understood.*

The attention of the authorities in the Tenasserim Provinces, as well as Arrakan, have already been attracted to the subject, and reports from Mr. Blundell and Captain Bogle have been received, which prove, that they are engaged in collecting information, which will doubtless be the means of leading to the improvement and encouragement of fisheries.†

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* A memorandum enclosed with Dr. Heddle's letter shews the amount of exports from Bombay, during the official year of 1839-40, for sharks' fins and fish-maws to be 2,82,383 rupees. The following places are given as the sources of these supplies: Malabar Coast, Cutch, Scinde, Mekran, Muscat, Bunder Abbas, Goa, the Coasts of Concan, Damaun, and Surat. Those exported from Scinde and Damaun are reckoned the best, those from Malabar are inferior. These different qualities in the *B'hăt* depend, we conceive, upon the species of fish from which it is taken, and not upon the place

† Mr. Blundell, the Commissioner of the Tenasserim Provinces, to whom at the desire of Lord Auckland, we communicated all that had been done in Calcutta on the subject of Isinglass, writes to us from Moulmein, 24th June 1841, that having given to a friend at Amherst all the information collected in Calcutta about Isinglass, he commenced some inquiries, the results of which he wrote to me as follows: "The Polynemus Sele, called by the Burmese *Káthay*, frequents our coast. I had one brought to me yesterday, which is the perfect fish described in the *Asiatic Journal.* I send you the Isinglass taken from it. The fish was about 13 inches long, and judging from the size of the sound, and its weight in comparison with the description of McClelland, I should be inclined to say, that it is infinitely superior. * * * The large specimen I found in possession of a Chinaman, and on inquiry of the Burmese, I find it is procured from the same fish of a large size. The season of their visitation in numbers, is on the approach of the dry weather, when by arranging with the fishermen, a large quantity may be collected.

It would appear from the information collected by Mr. Blundell, and referred to below, as well as in the report of Mr. E. O'Reily, recorded in the second volume of the *Calcutta Journal of Natural History,* that the Polynemus sele frequents the estuaries of the Irrawaddi during the cold season, precisely as it does those of the Ganges, and as we learn from Dr. Heddle, those of the Indus and Coast of Scinde. With regard to the Isinglass, Mr. E. O'Reily remarks, that the article never having been noticed in the Moulmein river before, it appeared difficult when he wrote, (August 1841,) to say to what extent it may be procurable. The arrangements proposed by Mr. O'Reily to the head fisherman, of erecting *stake-traps* at the mouth of the river, seemed to promise about 500 viss, or 2000 lbs., as the probable amount of Isinglass that may be collected during the dry season. Similar arrangements might be made at the mouths of the Great Tenasserim and other estuaries along the Coast.

Captain Bogle, Commissioner of Arrakan, to whom at the desire of Lord Auckland we gave in August last a specimen of the Sulea fish to shew to the people on that Coast, together with all the information in our power, soon after informed us, that the Sulea fish is found at Arrakan in great abundance and perfection. It is there called *Lukwah,* and

The large sounds, as per specimen, are at this season imported from Rangoon, and sell here at 1½ rupee per viss. The Chinaman says, the smaller specimen is much finer, and would bring a much larger price if imported with others, but I suppose the Burmese look more to quantity than to quality. I should very much like to hear McClelland's report on it, especially the smaller specimen, which I think is very fine, and certainly more plentiful in the fish here than in that described by him." The small fish alluded to in the foregoing note is the young Suleah, the large sound being afforded by the adult fish; our own observations rather prove the sounds of the adult fish to be the purest, although both Dr. Heddle and Captain Bogle state, that small sounds bring a higher price in China: the subject requires further investigation.

appears in the estuaries in shoals about the middle of January, and disappears in April; its usual size is from 3 to 4 feet long; about 10,000 of these fish, large and small, are taken annually at Arrakan.

The Mugs split these large fish open, and dry them in the sun; and until within the last few years threw the air vessel away; but since then, they sell this to petty dealers at from sixteen to eighteen rupees a maund for the large size, but twenty for the average description, and sell them again to the Chinese at 30 rupees per maund. Captain Bogle adds, the Chinese export the dry bladders to Penang, where they are in great request, and bring, it is said, forty or fifty dollars.*

Taking the value of the export from Bombay, as stated by Dr. Heddle on the best authority on the spot as our guide, the quantity annually exported from that port would be, at 20 rupees per maund, 1,129,520 lbs. Now we have found, that for every lb. of Isinglass 100 lbs. of fish must be taken. Thus supposing, as there is much reason to believe, the article exported to China as shark's fins and fish maws to be chiefly Isinglass, 50425 tons of fish must be taken to produce it. The question therefore arises, what becomes of the fish; what proportion of it is consumed fresh; and how much of it is cured? The fishermen who in two months supplied us with 75 maunds of fish sounds in December and January 1839-40, must have taken 250 tons of fish, not one-tenth part of which we believe, was turned to any useful account. Captain Bogle indeed states, that in Arrakan the Mugs split the fish open and dry them in the sun, after removing the air vessels, and sell four or five fishes in this state for a rupee without salting, or otherwise preparing them.

It is very much to be feared, that their method of curing fish at Bombay is not much better than at Arrakan, and that a vast source of prosperity and trade is thus lost not only to our coasts, but particularly to the interior, where

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* *Calcutta Journal of Natural History*, vol. ii. p. 615.

fish is dear, and provisions of all kinds often scarcely sufficient for the population.

The estuaries and western shores of the Persian Gulf abound in shoals of what we now know to be a superior fish, not merely as an article of food, but also superior in the production of another article of high commercial value. We have also found, that the same species is equally abundant during the cold season along the western shores of the Bay of Bengal, where up to the present time, it has been almost entirely neglected.

These two facts are of the highest practical importance. We can infer from them, that the natives of the Malay Coast may, if they like, contribute three lacks of rupees to their exports, the same as the people on the Coast of Malabar; as they have the same fish in the same vast shoals, and the same means of fishing if they like to employ them, besides the advantage of being so much nearer to China and the Straits, hitherto the only market for *fish maws*.

But as another market is now opened for this article in a more improved and pure state, the fishermen may obtain higher prices, and thus be enabled with European assistance to bring improved means to bear upon their employment.

We have estimated the quantity of fish taken on the Malabar Coast annually from the amount of *fish maws* exported, to be upwards of 50,000 tons, of this probably not above a 10th part is made available for the supply of food, perhaps for want of salt.

What we would here recommend is, that a premium be allowed on salt fish, equal to the duty on the salt used in curing it. It would also be desirable, that attention should, if necessary, be directed to the production of salt suited to curing provisions. The best salt for this purpose, and which is used in England, is made in the south of Europe from sea water by solar evaporation, and imported as *Foreign Bay Salt.* But the native salt merely washed, and recrystallized, would answer the purpose. There is, however, considerable variety in the native salts in different districts, but in general their impurities appear to depend on the evaporation of sea water to perfect dryness, instead of allowing the last portion of the solution, which consists chiefly of muriates of magnesia, lime, and sulphate of soda to drip off.

Salt for curing provisions should not contain above two or three per cent. of these last named impurities; whereas, if sea water be evaporated to dryness, the result will contain in addition to muriate of soda, above ten per cent. of sulphate and deliquescent muriates, which absorb moisture, and have no antisceptic properties, but the contrary. Salt for curing provisions should also be large grained, hard, dry, and coarse, but white. When such salt is used, fish or other provisions may be as perfectly cured in India during the cold weather, from the end of November to the end of January, when the Sulea fish is in season, as in any other climate.

The only other distinct propositions we can venture to urge at present is, that an experimental fishery be established at Amherst, where Mr. Blundell reports arrangements for the purpose to have already, in some degree been made, and that regular information regarding the progress of the experiment may be reported.

A figure, (Plate vi.) together with a few remarks on the history of a species promising to become so important to the commerce of India, may not be here out of place. *Polynemus plebeius*, *Polynemus lineatus*, and *Polynemus sele*, are names which have been proposed by different authors for the same species.

It was first made known to naturalists by Broussonnet, from a specimen obtained by Sir Joseph Banks at Otaiti, where it is called *D'emoi*. About the same period, Dr. John, a missionary at Tranquebar, one of the earliest, and at the same time one of the most distinguished, explorers of the

Natural History of India, communicated a figure, together with a description of the species, which subsequently appeared in Bloch's great work on Ichthyology, which appeared about the close of the last century. The figure given by Lacèpéde, was communicated by Commerson from the Isle of France, and a specimen of the fish itself, the only one we believe in Europe, is in the Royal Museum of the Netherlands. Bruce, the African traveller, also met with the species on the borders of the Red Sea, but erroneously figured it as one of the fishes of the Nile. Lastly, Buchanan Hamilton describes it as one of the species of the Ganges. Cuvier and Valenciennes, from whose great work on the Natural History of Fishes,* we have derived the above particulars, give as its habitation the whole of the Indian Seas and adjoining parts of the Pacific.

All authors who have noticed it, speak in high terms of its delicacy and wholesomeness as an article of food, and of the excellence of its flavour. Commerson found it to be confined in the Isle of France to the tables of the rich, but Dr. John found it in such abundance at Tranquebar and other places on the Coromandel Coast, as to render it extraordinary that his observations regarding it have excited so little attention in India. It assembles, he says, in the month of January when it is in season, in great numbers on the coast in search of clear water on the sand banks, and at the mouths of rivers for spawning, which takes place in April, and is taken in large numbers in the mouths of the Kishna and Godavery; each fish he describes as four feet in length, and the head in particular he remarks is reckoned above all other parts a most delicate morsel.

Buchanan merely speaks of its fine flavour and superior qualities as wholsome food, but not one of these authors appears to have noticed the remarkable value of its air bladder, which surpasses in size and also in importance that of

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* We annex a translation of their remarks on the subject.

the Beluga itself. The following list of names by which it is known on different parts of the coast, may be useful in addition to the figure, which we now give, Plate VI, from Buchanan's unpublished drawings.

Sélé, Bengal, (Buchanan.)
Suleah, Bengal, (Anonymous.)
Seer, in Scinde, (Heddle.)
Dara, Bombay, (Heddle.)
Lukwah, Arrakan, (Bogle.)
Ka-tha, Tenasserim. The small or young? (O'Reily.)
Ka-ku-yan, Tenasserim, the large when in season, (O'Reily.)
Kala mine, Tranquebar, (John.)
Pole-kala, Pondicherry, (Leschenault.)

Note.—The species is distinguished by the great size of its air vessel, and by the presence of five tendrils or bristling feelers placed on the breast on either side below the pectoral fins. We have ascertained that *Polynemus quadrifiles*, distinguished by four tendrils on each side, has no air vessel whatever. We had before pointed out the same peculiarity in *Polynemus paradiscens*, so that *Polynemus Sélé*, or as it might now be appropriately named *Polynemus gelatinosus*, is not to be mistaken for any adjoining species.

CALCUTTA, *26th February*, 1842.

Extract of a Letter from Assistant Surgeon J. M'CLELLAND, *to* G. A. BUSHBY, ESQ., *Secretary to the Government of Bengal, &c. &c. &c. under date* 26*th February*, 1842.

As the experiments were not undertaken with the previous sanction of the Government, I cannot in consequence make any claim for the actual cost with which they were attended; but if their utility be allowed, and the results be found to prove of practical interest, I may then trust to the liberality of His Lordship for the reimbursement of that deficiency, which will appear on comparing the debtor with the credit side of the Isinglass account for 1839-1840, and also for 183 rupees, the actual cost of 61 seers of Isinglass, forwarded through the Government as a sample to the Honourable Court.

Extract of a Letter from G. A. BUSHBY, ESQ., *Secretary to the Government of Bengal, No.* 264, *to* J. M'CLELLAND, ESQ., *M. D., under date* 26*th February,* 1842.

In reply to your letter dated this day, submitting a full report on the results of your enquiries and experiments to ascertain the value and the source of East India Isinglass, I am directed by the Right Honorable the Governor to acquaint you, that a copy of the report in question will be forwarded for the information of the Honorable Court of Directors, and that although the Honorable Court have not yet noticed the first communication respecting the expence incurred by you in this enquiry, his Lordship is pleased to authorize you to be compensated to the extent of rupees 2,280 : 4 : 4, being the net expense incurred after deducting the amount realized at the Home market by the sale of the article experimentally manufactured, and I have to enclose a Treasury Order for the amount.

Total Expense incurred, ... Rs.	3086	0	6
Deduct:—			
Sale proceeds 102*l.* 19*s.* 11*d.* at an Exchange of 2*s.* 1*d.*	933	12	2
Balance, Rs.	2097	4	4
Add costs of 61 seers sent to the Honorable Court, ...	183	0	0
Net Expense, Rupees	2280	4	4

Extract of a Letter from DR. HEDDLE, *dated Bombay, April* 26, 1841.

That form of Isinglass which is prepared by simply drying the swimming bladder of certain fish that frequents the coasts about this, is an article of export from Bombay to China. The substance is called "*B'hot* by the Mahrattas, and *P'hot* by Guzeratees and Scindees. There are three species of fish, from which the bladder is usually extracted for this purpose. The first is called by the natives of Bombay *Dara,* and by the Scindians *Seer*: it furnishes the best *B'hot,* and I believe also, the largest proportion of that which supplies the market is taken from it. This fish frequents the whole of the western coasts of India, particularly the coast of Scinde, and it penetrates up the estuaries of the Indus, where it is caught at Gorabari and other places on the Indus, to which the influence of the tide reaches. It is met with also at the mouths of the Euphrates, for an Arab merchant of Bussora, who went with my people to the bazar to procure the fish, singled out this as the one from which the bladder is extracted in the Bussora river, the estuaries of which it frequents. I have given a figure of our *Dara* in the drawing numbered 2. The fish attains the length of 4 feet at least, but the usual size is 2½ to 3 feet. It is caught in great abundance about Bombay, and the flesh, which is esteemed wholesome by the natives, is very commonly eaten. The fish are generally found in the Bazars with the bladder previously extracted. These are taken out by the fishermen, who sell them to a certain class of Muslem merchants called *Khojah,* who are the principal dealers in this article. The fishermen sell them in a fresh state, the *Khojahs* dry and otherwise prepare them for exportation. That prepared in Bombay is the least esteemed, and the lowest priced. The reasons for this inferiority seem to be, that the substance is not perfectly dried, and is liable to be attacked with maggots. Another reason is, that the bladders are not so thick as those which are more esteemed. Damaun and the coast in that quarter furnishes the article of superior quality at Bombay, but the best of all, and the largest quantity, comes from Scinde and from the Mekran coasts. The *B'hot* of Scinde is of larger size, is well dried and hard, but generally of a darker colour than that prepared in Bombay, and this latter difference appears to be owing to the fact, that in Bombay the bladders are dried in the shade, whereas in Scinde they are exposed from the first to the sun. The best Scinde *B'hot* sells for 20 to 25 rupees per maund, and fetches in China from 80 to 90 dollars per picul of 4¾ maunds.

The second species from which this substance is prepared, is called both by the people here and in Scinde, *Gol.* This is figured in the drawing numbered 1. It attains the length of 3¼ feet and upwards. It is inferior to the *Dara,* both as an article of food and on account of the quality of the *B'hot* it furnishes. However, a large quantity of the article extracted from this fish is brought to market. It is prepared exactly in the same way as the *Dara,* and sells here for 15 to 18 rupees per maund. Although the *Gol* frequents the coasts of Scinde, the people of that country say, that it never enters the river, but is always caught in salt water. No use whatever is made of the *B'hot* in Scinde; it is simply prepared and exported to Bombay, and eventually to China, nor am I aware at present that any of this substance is consumed in Bombay.

The *Khojah* were asked by my people, why they did not export their *B'hot* to England? But the reply was, that upon enquiry they found, that the demand for this article in England was very limited.

There is a third species from which *B'hot* is extracted, called here *Kota.* This fish is rare on our coast, but appears to be more abundant to the westward, especially about Muscat, where it is well known. The *B'hot* from this is universally admitted as inferior to the others, and consequently little of it is brought to the market.

The sample which accompanies this is the *B'hot* of the *Dara,* (the *Seer* of the Scindeans,) prepared in Scinde. It will shew the nature of the substance, which if prepared with care, by the process used by the

Russians would no doubt furnish Isinglass of the best quality. More detailed drawing of the "*Seer*" and "*Gol*" fish shall be communicated hereafter, with a drawing of the *Kota* as soon as one can be procured, and a drawing also of the fish from which Caviare is prepared. This substance is called *Gubolee* by the Mahrattas, and the fish from which it is procured, "*Soormaee.*" The best comes from Scinde, but unlike the *B'hot* it is most prepared for home consumption, that is in India.

Extract of a Letter from the same, dated Bombay, August 9, 1841.

I had a drawing of each of the species now sent taken for you, but I imagine that Dr. Brown may not have forwarded them in the hurry of departure. The delay which has occurred in answering your letter, has arisen from my not being able to procure the third species mentioned in my note as yielding the *B'hot*, that called here "*Kota.*" From the fact of my not being able to procure one since I received your letter I am led to conclude, that the habit of this fish is migratory, though the fishermen will not distinctly admit the fact. They say, it is *scarce* on this coast. I am assured, however, that I shall meet with it this month, and if I succeed, I shall despatch a specimen by the first vessel in the same manner as the last.

With regard to the habits of *Gol* and *Dara*, the enquiry I have made would lead me to conclude, that neither species is migratory. Both are caught in Bombay throughout the year. It is true at some seasons in greater abundance than at others, but this is said by the people to depend on circumstances quite unconnected with the presence or absence of the fish. About June, and again in September, the number taken is small compared to the intermediate periods. At these times, the fishermen change their ground. In June removing their tackle, &c. from the deep sea-fishing stakes, which are fixed off the west coast of the island, in the open ocean, to other stakes fixed in the piece of sea to the east of the island, and situated between it and the main land. Here the fishing is continued during the south-west monsoon; and in September they move again outside. The fish also shift their ground; at least none are taken in the inner water during the fine season.

The information I obtained last season from the Mohanas of Scinde, would lead to the same inference with regard to the stationary habit of these two species on their coast. They say, that on the coast of Scinde and the eastern part of Mekran, the fish are not taken during the S. W. monsoon, because the boats do not go out at that season. The

Dara, however, which pushes into the Indus, is caught even during that season in the estuaries of the river.

With regard to the abundance of both the kinds in question on this coast, I have been repeatedly assured, that at some seasons during the springs, the bazars of Bombay and neighbouring ports along the coast are literally glutted. This I have observed myself frequently. Vast quantities are consumed by all classes of natives in the fresh state, and likewise salted. In the latter state it is sent into the interior, but by far the largest quantity is consumed by the sea-faring population of this part, both those navigating the small craft, as well as the large. It forms with them their stock of salt provisions. In this point of view, both these fish are extremely important, and the trade in the other production of the same species (the *B'hot*) must be of secondary value to it. I will not trouble you with further details on this subject at present, but enclose an original memorandum of the ports from which the bladders of the three species yielding this substance are imported.* It will give you an idea of the quantity that must be produced, as well as the space over which the species are met with. The fish dried and salted, are imported from the same places.

I shall in the ensuing fine season induce one of the people engaged in the preparation of *B'hot* to prepare some by the method you communicated, and inform you of the result.†

Hereafter I hope to be able to furnish you with a list of all the fish to be found in this bazar at different seasons, with drawings of some, or all of them if possible. Also an account of those which the fishermen here admit to be migratory, such as the famous Pulla, which is caught in the Indus at certain seasons, and which is known also here, and another fish of small size, (the name I have forgotten,) but which is valuable as yielding a fish-oil much used on this, and the Malabar coast.

The Remarks of Baron Cuvier and M. Valenciennes, on Polynemus plebeius, Brouss.; *Polynemus Lineatus,* Lacep.; *Polynemus Sélé,* Buch.; *from the Histoire Naturelle des Poissons.*

Our first species with five filaments appears to be the *Polynemus plebeius,* of which Broussonnet has published a very exact detailed des-

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* See note page 175.

† We regret to find that Dr. Heddle soon after this was written, was obliged to leave Bombay for the benefit of his health, which however became worse, and death deprived us of an intelligent and obliging correspondent at Bombay, and the public of an excellent servant.—Ed.

cription.* It was Sir Joseph Banks who furnished the specimen, and who procured it at Otaheite, where it was named *D'emoi.* The sailors of the first expedition of Cook also caught them at the Isle of Tanna. In the Royal Museum of the Netherlands, there is a specimen which came from Java. It is as we have said the *Polynemus* figured by Commerson from a specimen caught at the Isle of France,† and the *Kala-mine* of Tranquebar sent to Bloch by John; we have also received it from Pondicherry through M. Leschenault, under the name of *Polekala.* Lastly, Mr. Buchanan believed, with every reason for the truth of his opinion, that it is the *Sêlê* of the Ganges. They are therefore to be regarded as inhabiting the whole of the Indian and warmer parts of the Pacific Oceans, but we do not know where Bloch has taken his authority for its also being found in America. Admitting as we may, the identity of these subjects, we may regard the Polynemus as a fish remarkable for its fine flavour and the size which it attains on certain coasts. According to John, as quoted by Bloch, it attains in Malabar four feet in length, and we have seen in the Royal Museum of the Netherlands an individual from Java, forty-five inches in length. John adds, that it is one of those species on which the name of Royal Fish is bestowed in the Colonies, and by the traders on the Coromandel Coast, with whom the head is considered a delicate morsel; they are dried and salted, and also preserved with spices. They are seen in great quantities on the Coasts in search of clear places on sand banks in the mouths of rivers. They afford much fishing in those of the *Krishna* and *Godaveri.* They are in season in January; they spawn in April.

We found in a manuscript of Commerson, recently communicated to us by M. Hammer, that at the Isle of France, where they are named *Barbue,* they are caught in small quantities all the year, and being scarce, are reserved for the tables of the rich.

If it be the same as the *Sêlê* of the Ganges described by Mr. Buchanan, it does not enjoy such a character in Bengal. This author says merely, its flesh is light, and something like that of the *Bola,* or as others say, like our *Merlan;* but that numerous species are preferable for their flavour. They are caught in great numbers in the mouths of the Ganges, and weigh from 20 to 24 lbs. At Pondicherry, they appear to be smaller, for it is remarked by M. Leschenault, that they are a foot in length; they may be taken all the year round on the coast at Pondicherry, but are not common. It will be for those observers

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* Dans le premier et l' unique cahier de son Ichtzologie (Copiè dans l'Encyclopedie Methodique Ichtzologie, fig. 209.)

† Copied in Lacepede, t. v. Pl. 13, fig. 2.

who reside on the spot to determine the nature of these discrepancies, and whether they are owing to varieties, or to geographical position, or to different species being confounded, from the want of means to make direct comparison of those species of which the characters differ but little. An Indian naturalist, who had only isolated descriptions of many of our Cyprins, would be very liable to overlook those differences which we have found it difficult to seize when comparing nearly allied species, and which our fishermen never mistake. But a confusion of species, for which there is no excuse, is, that which was made by Bruce, on the very species we are now describing. He has given in his Travels, (Plate 41,) an exact figure from a drawing which appears to have been made on the coasts of the Red Sea : but by one of those blunders with which the work is replete, the name *Binny* is written at the bottom of the plate, and if you refer to the text, you will find the true *Binny* is a fish of the Nile, of the genus *Barbus,* (the *Cyprinus binny,* Forsk et Gmel.) There is no Polynemus in the Nile, and on this extraordinary mistake of Bruce, is founded the species *Polynemus Niloticus* of Shaw.*

Our specimen from Pondicherry is a little shorter in proportion, the head a little larger, and the second dorsal and the anal more pointed than the *Polynemus tetradactile,* to which in other respects it bears a close resemblance. The denticules of the preoperculum are also smaller, and the inferior angle is round. The teeth are in straiter bands and descend less outside of the lower jaw. Not only has it one ray more, but the three first rays are longer than the pectoral, while in the *Tetradactylus,* they are shorter. The ventrals are situated behind the pectorals, and reach almost to the extremity of the free pectoral rays. The lateral line extends in a line from the superior angle of the operculum to the tail, on which it is prolonged a little downwards with its slope.

The number of its rays.—D. 8 : $\frac{1}{14}$ a $\frac{2}{13}$: C. 17 : P. 17. v. $\frac{1}{5}$.

Our specimen is silvery, with longitudinal grey or dark lines formed rather by reflection than true tint, and prevailing along the whole of the back to the tail. The fins are pointed and dark. M. Leschenault, to whom we owe this specimen, and who saw it when fresh, assured us, that the muzzle of the fish is transparent as gum; and Commerson also says so. In this state, the brown lines of the back are less apparent, for M. Leschenault has described this species as grey on the back and white below the belly. Commerson has given it only one colour, a bluish silvery tint towards the back. The figure of Com-

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* Shaw, Univ. Zool. t. v. part 1st, p. 151.

merson, upon which M. de Lacèpéde established his *Polynemus lineatus* is in fact drawn from a dry specimen, and we are certain, that it is the same species with that which we have received from Pondicherry, since we are in possession of the original specimen as well as the original drawing, and have made a comparison with this and other individuals.

According to our observations, the Polynemus has a very large swimming bladder, thin and without appendages; its stomach is a *cul-de-sac*, and its pyloris is furnished with innumerable small cœcums.—*Histoire Naturelle des Poissons, t. 3me, p.* 281, *Paris*, 1829.

J. M.

Europe:—A popular Physical Sketch. By Professor Schouw, *communicated to the Calcutta Journal of Natural History, by Dr.* T. E. Cantor.

(Continued from vol. ii, p. 16.)

In consequence of the considerable height of the South European Mountains, the South European on ascending them arrives at climates and vegetations similar to those of the North of Europe, whereas the North European in his own country, remains ignorant of the nature of the South of Europe. Thus the Italian or the Spaniard on ascending his mountains, may see beech-forests, hazel-bushes, rye-fields, and luxuriant meadows; ascending still higher, he meets with plants of Lapland and snow at midsummer, while the North European in his own country, never knows the mild winter or the clear sky, nor sees the laurel, myrtle, nor the evergreen forests, olives, nor oranges.

The smaller extent of surface of the south of Europe, and the greater encroachment of the sea, are the causes that no rivers can equal in size those of the great plains of the north. The largest rivers in Europe, Wolga, Danube, Dnieper, and Don, appear all to the north of the great mountains, where also the lakes in extent and number surpass those of the south, particularly so in the countries surrounding the Baltic. The structure of the mountains is not very different in the north and the south. Mines are particularly found in the north: England, Scandinavia, Hungary, and Saxony.

The mean temperature of the north of Europe appears to be between 27.5°* Fahr. (the supposed mean temperature on the north coast of Russia), and 56.7°, (Dax and Bordeaux); that of the south of Europe between 54.5° (Milan) and 68° (supposed mean temperature of the south coast of Sicily.) If coasts and plains solely be taken into consideration, the difference in the mean temperature is greater in the north; but the low mean temperature of the north appears also on the lofty mountains of the south; thus for instance, the mean temperature of St. Gothard is from observations 29.8°, and from a probable calculation 28.63° on the summits of Etna and the loftiest peak of the Apennines, and 5° on the top of Montblanc, whereas the highest summits of the northern mountains scarcely have a lower mean temperature than 14°.

Owing to the extensive inland plains, a greater difference in the climate of the eastern and western extremities exists in the north of Europe, than in the south, which is in immediate contact with the sea.

The coasts of the Atlantic and its islands possess the mildest climate, whereas in the south of Europe the coasts of the Atlantic have a climate less mild than the corresponding part of the Mediterranean between Spain and Italy.

The climatic difference between the north and south of Europe consists much more in the winter than in the summer temperature, which will appear by the following comparison:—

	Winter.	*Summer.*
Palermo,	52·2°*	74·°
Vienna,	32·°	68·°
Copenhagen,	30·9°	63.5°
Stockholm,	25.°	61·2°

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* The temperatures were given according to Reaumur's scale; we are responsible throughout for their reduction to Fahrenheit.—*Editor Calcutta Journal Natural History.*

The difference in the summer temperature between Palermo and Vienna thus amounts to only 6°; in the winter temperature to 20.2°. The summer in Stockholm is only 13.5°, while the winter is 27.2° below the winter temperature in Palermo.

That this applies still more to the highest degrees of heat and cold,* will be seen in the table :—

		Highest.	*Lowest.*	
Stockholm,	68 years,	95·°	26·5°	below zero.
Copenhagen,	52 years,	93·85°	13·°	ditto ditto.
Rome,	40 years,	100·62°	21.88°	above zero.
Palermo,	34 years,	106·2°	32.°	ditto ditto.

This difference between the seasons and the proportionally great summer heat in the north, exerts a very salutary influence over the vegetation; the severe winter cold indeed checks the vital activity, but does not destroy it; whereas the high summer temperature of the long summer days, promotes the growth of the plants, the ripeness of the fruits and seeds. If there were no difference in the seasons, or in other words, had the north of Europe perpetual spring, we should in Copenhagen, for instance, never see snow or ice to be sure, but we should also never see corn or fruit ripen, nay, we should see no trees at all. In the high land of South America, under the line, where there is no great difference between the heat of the seasons, grain cultivation ceases already at 25° above the freezing point, (the mean temperature of Milan,) and the tree vegetation at 18°, (the mean temperature of Carlsruhe); if such was the case in Europe, there would exist no grain cultivation north of

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* Every comparison of observations of the highest and lowest temperature is rendered somewhat uncertain, from the circumstance, that the spot where the thermometer is placed, by name the elevation over the ground, exerts a much greater influence over the highest and lowest temperature, than it does over the mean temperature. Supposing even the data in the Table be incorrect, say one or two degrees, the correctness of the statement will be apparent nevertheless.

the Alps, and no forests north of Paris, Carlsruhe, Prague and Ofen.

The salutary influence of the change of seasons becomes also apparent on comparing the coasts and islands of the northern parts of Europe, with the interior of the Continent. Iceland and the Fär-island produce neither forests nor corn, while both flourish on a much more northerly latitude on the Continent, where the summer heat is greater, but the annual mean temperature is less. For the very same reason, the vine and maize limit does not extend so far northward on the west-coast of France as in Germany.

Such European plants as require a very mild winter, are of course not to be expected to grow in the north of Europe; for instance, the ever-green trees, the olive, and the orange-tree, and these therefore are peculiar to the south.

Another consequence of the greater difference between the seasons in the north, is, that the arrival of spring is much more conspicuous. The mild air relieves the severe cold, the frozen lakes and rivers thaw, the snow-cover of the earth disappears, making room for grass and herbs; the trees shoot leaves, the itinerant birds arrive, and the insects are called to life. In the south, on the contrary, where no snow hides the earth, where field and meadows are verdant in winter, and where most trees and bushes retain their leaves, the only change consists in a greater number of plants springing and flourishing, a greater number of trees shoot leaves, and a greater number of birds and insects make their appearance. The arrival of spring forms there a much less important era in the life of the husbandman, who, the whole of the winter, may work in his field, garden, vine, or olive yard.

The annual quantity of rain depends on the locality and physical condition of the countries to such a degree, that it is impossible to produce any thing like a comparison between the northern and southern Europe. In lofty mountain districts, the quantity of rain is very great, particularly on the south and west side, whither the wind carries vapours from the warmer regions and the sea. Coasts and islands appear to receive a greater quantity of rain than the large plains on the interior of the Continent, *cæteries paribus;* the quantity appears greater indeed in the south of Europe, particularly on the south side of the Alps, and the same side of northern part of the Apennines. But the vicinity of the torrid Africa, in conjunction with the great elevation of the Spanish table-land, are the causes of the scanty annual supply of rain in the southernmost part of Europe. In the distribution of the rain, however, a great difference exists between the north and the south of Europe; in the former the quantity is tolerably equally distributed throughout the four seasons; yet the greatest quantity falls in summer and autumn. In the south of Europe, on the contrary, the summer rain is very scanty, the autumn and winter the proper rainy seasons; and the farther we advance to the southward, the more the summer rain decreases, and the winter rain increases. Also the number of rainy days is greater in the north than in the south, where the fall of rain is more rare, but the more violent. Snow, being so conspicuous in the north, (particularly towards east) of Europe, is a rare occurrence in the lower regions of the south of Europe; hail-stones, on the other hand, are much more common in the south, and there much more dreaded by the husbandman.

Lightning and thunder seldom appearing in the north, except in summer, are common phenomena in the south throughout every season, but particularly in autumn. Of an hundred thunder storms occur

	Winter.	*Spring.*	*Summer.*	*Autumn.*
In Copenhagen, ...	1	18	70	11
In Palermo, ...	15	15	22	48

The sky is much clearer in the south of Europe than in the north.

In the south of Europe, the daily changing land and sea winds are frequent, particularly in summer. During the day, the land-air is more heated than the sea-air, for which reason the air rises over the land, and pours in from the sea. At night, on the contrary, the sea-air is warmer, for which reason the land-air streams towards the sea, of such change of wind but slight traces are observed in the north of Europe. The hot enervating winds *(scirocco, solano,)* which blow in the south, are unknown in the north, where also little is perceived of the pestilential air, which infests so many tracts of country in the south.

The chief distinctions between the vegetation of the south and the north are,—the south produces a greater multitude, and by name a greater variety in species of trees and shrubs, a greater number of tropical forms of plants, of creepers and bulbs, of beautiful flowers and scented herbs; wherewithal the evergreen foliage is peculiar to the south of Europe. On the other side, the grass vegetation is much more luxuriant in the north, owing to the summer rain, which is much rarer in the south, which during that season gives an arid greyish-yellow appearance to the grass.

Although the wheat is also much cultivated in central Europe, and in some countries is the principal grain-sort, rye nevertheless is characteristic to the north; whereas wheat, maize, and partly rice are the common grain with the south European. Potatoes and buck-wheat, of great importance as food in the north, are rare in the south. Beer is common beverage with the north, wine with the south European; yet the vine-limit lies to the north of the dividing mountains. The oil and butter, on the contrary, correspond exactly to the dividing medium between the two principal parts of Europe.

In the south of Europe, vegetables and fruit are much more generally cultivated than in the north, and there is also a greater variety of oranges. Pistachios are found to the south only of the great mountains; apricots, peaches, almonds, figs and grapes, although extending farther northward, appear in a small part only of the northern Europe, and there not unless cultivated with great care and art.

These differences in the productions must produce a considerable contrast in regard to the food of the inhabitants. Rye bread, beer, butter, a greater quantity of animal food, and a less of vegetables and fruit with the north European; wheat bread, maize, wine, oil, a greater quantity of fruit and vegetables, and less animal food with the south European.

Hemp and flax are more commonly cultivated in the north. The cotton plant in the south only, and rearing of silkworms also, is nearly exclusively confined to the south.

The wild mammalia offer no striking contrast between the north and south; the Arctic countries only possess some peculiar large animals, as the reindeer and the polar bear.

Serpents and lizards are much more common in the south of Europe, as also the number of insects and molluscs increase towards the south. The southern seas are inhabited by a greater number of species of fishes, but the number of individuals appears greater in the northern, for which reason the north European supplies the south European with fish. The most important fishes of the north are the different species of '*Torsk*,' (Brosmiusco,) and herring; that of the south is the tunny.

The domesticated animals, as well mammalia as birds, are the same in the south as in the north, except perhaps the ass and the mule, which, more common in the south, don't extend far beyond the line of demarcation, and the reindeer, which is domesticated in the northern Scandinavia.

The complexion of the south European, his hair and eyes are darker; the form of his body less clumsy; he is more agile; is thinner clad; lives more in open air; and has fewer necessities. He is more exposed to fevers, while diseases of the chest and gout are more common in the north.

Europe considered as a whole, is situated between 35 and 71° north latitude; a small part only belongs to the Arctic zone; the rest is situated in the temperate zone, which, if divided in two, taking the 45° north latitude as the line of demarcation, will place by far the greater part in the colder temperate zone. Europe is situated between 6° west latitude, (or if Iceland be excluded 7° 30′,) and 75° east of Ferro.

On east, Europe is thoroughly connected with Asia, and the transition is imperceptible. On this, the eastern frontier appears an immense plain from the Polar Sea to the Black Sea; continuing towards west, but is cut into a cuneiform shape by the Scandinavian mountains on one side, and Balkan, the Karpathians, Sudetes, Erzgebirge and the Harz mountains on the other side, and in this basin the Baltic is confined. West of the Harz mountains, the plain expands between the Atlantic on one side; the Weser, and the French mountains on the other. In this basin we might fancy the North Sea to be enclosed, the north-western brim of which in that case would be the British mountains. From this mode of view there would appear one large plain, divided into two minor ones, however, of unequal magnitude, by the Danish peninsula. From this enormous plain access to the Highland is opened first by the Hungarian plain, and the communicating deeply entering Danube-valley; secondly, by the equally deeply entering Rhine-valley. Although the Central European mountain chains in the preceding have justly been separated from themselves and from the Alps, they might, in a more common point of view, be united to those, and viewed as one immense Highland, if looking upon the base, on which the smaller mountains rest, as low side-terraces shooting from the Alps, and thus we obtain a definite distinction between the Highland and Lowland of

Europe. It has also been already observed, that both the Apennines and the Dinaric Alps are in connection with the Alps, and they might therefore be taken in under the same extensive Highland. The Pyrenées, on the contrary, are separated from those, but communicate with the mountains of the Spanish peninsula.

Europe would thus consist of four principal parts :—

1.—The large *south-eastern Highland*, including the Alps, the central European mountains, the Apennines, the Dinaric Alps, Balkan, and the Greek mountains. This is also the loftiest.

2.—A smaller *north-western Highland*, consisting of the Scandinavian mountains, and to which might be included also the mountains of Great Britain.

3.—A smaller *south-western Highland*, including the Pyrenées and the Spanish mountains.

4.—A large plain between these three Highlands, the Ural mountains, and the Atlantic Ocean.

The mountains of Crimea are isolated from the others; they are of small extent, and belong perhaps to Caucasus; also Iceland and some smaller islands come not within this division.

If all these mountains be classified according to their extent, the following classes might be established :—

1*st Class.*—The Scandinavian mountains, the Alps, Apennines, Karpathians.

2nd Class.—Balkan, the Dinaric Alps, the Greek and Icelandic mountains, (if they be admitted,) the Pyrenées, the Gallacian-Asturic mountains, Gaudarama, Serra Nevada, the Cevennes, Jura, the Scotch mountains, Serra Guadaloupe, Serra Morena, the Vosges, and the mountains of Sicily.

3rd Class.—The mountains of England, Sardinia, Auvergne, Böhmerwald, the mountains of Corsica, Schwarzwald, Rauhe Alps, the mountains of Crimea, Serra Monchique, the Sudetes, the mountains of Ireland, and the Fär-islands.

4th Class.—The Harz, Erzgebirge, and the rest of the smaller mountains in central Germany.

If these mountains be classified according to their highest summits we shall have—

1st Class.—Mountains reaching nearly 15,786* feet, the Alps.

2nd Class.—Mountains from 10,760 to 11,733 feet, Serra Nevada, the Pyrenées, and Etna.

3rd Class.—Mountains between 8,533 and 10,000 feet, the Apennines, the mountains of Corsica, and probably Balkan.

4th Class.—Mountains between 6,400 and 8,533 feet, Guadarama, the Scandinavian mountains, the Greek mountains, the Dinaric Alps, the mountains of Sicily, (Etna however excepted,) and Iceland.

5th Class.—Mountains between 4,270 and 6,400 feet, the Cevennes, the mountains of Auvergne, and Sardinia, Jura, the Sudetes, the mountains of Majorca, Crimea, Schwarzwald, the mountains of Minorca, the Vosges, and the Scotch mountains.

6th Class.—Mountains below 4,270 feet, all the rest whose height has been ascertained.

This order would be somewhat changed, if the mean height of the mountains was laid down as the standard, which does not always correspond to the height of the summits.

With regard to the direction of the larger *elongated mountain* chains, we find—

In East and West.—The Alps, Balkan, the Pyrenées, the Spanish chains.

In North and South.—The Scandinavian mountains, the Cevennes, Vosges, Schwarzwald, the mountains of Sardinia and Corsica.

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* The heights were given originally in Paris feet, we are responsible for their reduction throughout this paper to English feet.—*Editor Calcutta Journal Natural History.*

In North-west and South-east.—The Apennines, the Dinaric Alps, the Sudetes, and Böhmerwald.

In South-west and North-east.—Jura with Rauhe-Alpadn, the Scotch mountains.

Of a *rounded* form—The mountains of Auvergne, Harz, and some smaller ones.

Mountain groups from the mountains of Greece, Iceland, Sicily and Ireland, with those situated on the arched mound of the Karpathians.

Isolated mountains of considerable height, on the plains, are Etna, Hecla, Montserrat, Vesuvius, Gargan.

Of the plains, the east European is the largest, next to which the north European, then the Hungarian, after which follow the rest. Of the table-lands, the Spanish is the highest and most extensive, next to which the Bavarian.

Were the Rivers of Europe to be classified according to their respective length, they would follow thus :—

1*st Class.*—Volga and Danube.

2nd Class.—Dniper and Don.

3rd Class.—Rhine, Petschora, Dwina, Vistula, Dniester, Elbe, Loire, Tajo, Düna, Guadiana, Oder, Niemen, Duoro, Ebro, Po, Rhone, and Guadalquivir.

4*th Class.*—The rest of the rivers mentioned in the preceding.

The Caspian Sea receives the largest river ; the Black Sea the three next; of the 3rd class the Arctic Ocean receives two; the Baltic four ; the North Sea two ; the Atlantic five; the Mediterranean three; the Black Sea one.

With regard to their sources, three of the two first classes originate on the east European plain : the Danube from the Alps, the central European mountains and Balkan. Of the 3rd class rivers, three come from the Alps, four from the central European mountains, five from the Spanish mountains and the Pyrenées, and five from the east European plain. From this will be seen, that the largest rivers originate on the east European plain, and those next to them in the Alps.

The Scandinavian and the Greek Peninsula, and the European Islands possess no river sufficiently large to come under the three first classes.

It is already mentioned, that the north of Europe possesses more lakes than the south. The largest collection of lakes forms a broad belt south-east of the Scandinavian mountains in the north of Russia, Finland, and south Sweden; another parallel belt of smaller lakes appears on the south side of the Baltic. A third considerable collection of lakes, is that at the foot of the Alps.

The conspectus of the temperature of Europe is rendered easy by drawing lines, (isothermic lines,) through all such places which have an equal annual mean temperature. The considerable southern curvature of those lines in the east of Europe, proves that the heat decreases towards the east. Thus the isothermic line for 4° Reaumur falls a little south of Iceland, in the 63° north latitude, a little south of Drontheim in nearly the same latitude, but at the Baltic it sinks down to the 60° north latitude, and in Russia to 55°. These curvatures are larger in the north, than in the south of Europe.

It has already been observed, that the quantity of rain particularly depends upon the mountains, and the vicinity of the sea, and that the south and the south-west side of the south European mountains are the most rainy localities.

Perpetual snow appears in Iceland, Scandinavia, Balkan, the Alps, Pyrenées, and Serra Nevada. The summits of the Karpathians, Apennines, of Etna, and the Corsican mountains touch the snow limit. At the North Cape this line is 2,346 feet above the level of the sea, on Etna 11,182 feet. It sinks everywhere somewhat towards the sea. Avalanches (*Glaciers*, 'Gletschen',) appear in Iceland, Scandinavia, and the Alps, and faint traces in the Pyrenées and Karpathians.

As the sky is clearer in the south than in the north, so it is also clearer in the east than in the west, where the vapours of the sea frequently produce fogs and clouds.

The north limits of some of the most common trees form lines that bend to the southward in the western part of the north of Europe, thus indicating the vicinity of the sea being unfavourable to forest vegetation. The different trees, however, offer remarkable modifications in the latter respect. The north limit of the beech is much curved towards the south in the eastern part of Europe.

The northern limits of the most important cultivated plants are explained by the lines which also serve to explain how corn and vine cultivation depend upon the mean temperature of the summer, while that of the olives and oranges upon the mean tempeature of the winter.*

Taking into consideration the wild plants as well as the cultivated, Europe might be divided into the four following zones, provided all the mountains, the lower temperature of which of course change matters, be excepted :—

1.—*Northern Zone. The Zone of the fir and birch. The uncultivated Zone.* Here are either no forests at all, or birch and pine forests; some mountains; plants, none; or very little grain cultivation, (barley,) no fruit tree. The occupations followed here, are fishery and breeding of cattle. Iceland, Fär-islands, Scandinavia north of 64°, Russia north of 62°. Most of these regions are mountainous.

2.—*First intermediate Zone. Zone of the beech and oak. Zone of the grain.* Forest partly of pines,† partly of beech and oak, some heaths with heather; much grain, particularly rye; northern fruit trees; considerable breeding of cattle. The British isles, Scandinavia south of 64°, Finland,

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* The isothermal lines and the limits of several kinds of vegetation and cultivation are laid down in Professor Schouw's original sketch in various Maps, &c., which we are unable to introduce here.—Ed.

† Original " Needle Trees," which are probably *Pines.*—Ed.

the east European plain between 62° and 48° north latitude, the north European plain, and Denmark, mostly plains.

3.—*Second intermediate Zone. Zone of the chestnut and oak. Zone of the vine.* Forests of leaf-trees, principally chestnut, oak and beech. (Pines on the mountains;) grain, particularly wheat, also maize and vine. All the plains and valleys between and on the central European mountains, and the east European plain south of 48°.

4.—*Southern Zone. Evergreen Zone. Olive Zone.* Evergreens, wheat, maize, rice, vine, olives, southern fruits. In the southern part, oranges. The three south-European peninsulas. To these four zones, situated north and south of each other, correspond tolerably well those mentioned under the head of Italy, forming four principal zones of altitude; viz.—1. The evergreen zone, or the olive zone. 2. Chestnut and oak, or vine zone. 3. Beech and grain zone. 4. Mountain plant zone, or the uncultivated zone. The zone of fir and birch is missing, but it exists as a regular zone on the Alps.

From the chief occupations of the nations, the following geographical divisions might be established:—

Fishery, chiefly in the northern part of Scandinavia, Iceland, the Fär-islands, north of Scotland.

Breeding of sheep, particularly on the Spanish table-land, the mountains and plains of Greece, Puglia, Iceland, and the Fär-islands.

Breeding of horned cattle in the western part of the north-European plain, the British Isles, and on the Alps.

Cutting of wood on the Scandinavian peninsula, the northern part of the east-European plain, the eastern part of the north-European plain, on the Alps, and the central European mountains.

Cultivation of grain on the extensive east-European, and the north-European plain.

Cultivation of the vine in the south-European peninsulas and in the valleys between the central European mountains.

Cultivation of olives and southern fruits in the lower valleys of the south-European peninsulas.

Mining in the Scandinavian, Scotch, English mountains, the Harz, Eryzebirge, the Alps, Pyrenées, the Gallician mountains, Serra Morena, and the Hungarian mountains.

Land-trade, chiefly on the east and north-European plains.

Sea-trade in the west and south of Europe.

Manufactures, more extensive in the west (England, Belgium, France, north Germany,) than in the east; more so in the north than in the south. *Navigation* also is more important in the north than in the south.

List of the Heights quoted.

Names.	Paris. feet.	English feet.	Remarks.
Gousta,	5801	6150	Smith. Topogr. Stat. Saml. 2. D. 2 B.
Justedelsbrä,	6000	6400	v. Buch. Gilb. An. 41.
Skagestöltind,	7650	8160	Keilhau and Boeck, Mag. for Naturvid. 1.
Lodalskaabe,	6190	6602	Bohr. Morgenblad 1822, No. 155.
Sneehätten,	7099	7572	Hisinger, Antekn. 3.
Syltop,	5507	5874	Do. do. 2. 3.
Sulitelma,	5796	6182	Wahlenberg, Mättn.
Enontekis,	1341	1430	Grape. (Ehrenheim. Klim. Rörligh.)
Taberg,	1032	1100	Hisinger, Profiler.
Kinnekulle,	856	913	Do. do.
Rytterknägten,	480	512	Orsted og Esmark, Bornholm.
Finland, (greatest height)	1200	1280	Engelhardt. Darst. 1.
Oräfa Jökul,	6030	6432	Scheel MSS.
Oster Jökul,	5340	5696	Ohlsen, (Scheel MSS.)
Hekla,	5033	5368	Soekort Arkiv. Kort.
Slattaretind,	2712	2892	Forchammer MSS.
Skiellingfield,	2347	..	Do. Do.
Ben Wywis, Ben Newis,	4110	3722	Boué, Essai Géologique.

Names.	Paris feet.	English feet.	Remarks.
Cairngorm,	„	4083	Boué, Essai Géologique.
Hartfell,	3096	3376	Do. do. do.
Hellvelyn,	„	3227	Dalton, (Brewster's, Cyclop.)
Skiddaw,	2835	3024	Conybeare and Philips' Outl. of Geol.
Snowdon,	3377	3602	Brewster's Cyclop.
Dortmoor,	1681	1793	Conybeare and Philips', l. c.
McGillicuddy's Rocks,	3193	3331	Miltenberg.
Nephin,	2468	3632	Kirwan, (Brewster Cyclop.)
Montagnes d'Arrée,	942	1004	Berghaus' Map.
Côte d'Or,	1716	1830	Do. do.
Plateau de Langres,	1584	1689	Do. do.
Himmelbjerg,	510	544	Schouw MSS.
Aborrebjerg,	476	507	Schouw, (Paludans Möen.)
Veirhöi,	371	395	Wessel and Schouw MSS.
Stubbenkammer,	540	576	Brugiere Orographie.
Golmberg,	555	592	Mädler (Berghaus Ann. 1.)
Duberowberg,	443	472	Klöden (ibidem).
Hasenberg,	594	643	Ibidem, 2.
Mont d'Or,	5814	6201	Berghaus' Map.
Cantal,	5718	6099	Delambre, ibid.
Pierre sur Haut,	5964	6361	Ibid.
Mt. Mezin,	5322	5676	Ibid.
Lozère,	5280	5632	Hombre Firmas, (Bibl. Univ. 1832.)
Pré de Marmiers,	5300	5653	v. Malten (Berghaus, Hertha 13)
Réculet,	5280	5632	Do. do. do.
Mont Tendre,	5180	5525	Do. do. do.
Dôle,	5160	5504	Do. do. do.
Hohenberg,	3160	3370	Oyenhausen, Hertha 1.
Ballon de Sulz,	4337	4626	Miltenberg, (mean height out of four measurements.)
Ballon d'Alsace,	3870	4128	Andre de Gy. (Miltenberg.)
Feldberg,	4500	4800	Miltenberg, (mean.)
Malchen,	1573	1677	Oyenhausen and Dechen Map.
Brocken,	3506	3739	F. Hofmann, (Berghaus Ann. 1.)
Weser Mount,	1441	1537	Do. do. do.
Grosser Beerbery,	3150	3329	Berghaus, Erdbeschreib.
Schneeberg, (Fichtelgebirge,)	3221	3435	Bürg, Hofmann, Weiss, (Bergh. Ann. 4,)
Schwarzwald,	3769	4020	Hallaschka, (ibid.)
Heidelberg,	3860	4117	Miltenberg.
Arber,	3840	4096	Hoser, (Miltenberg.)

Names.	Paris feet.	English feet.	Remarks.
Schneekoppe, ..	4946	5275	Hallaschka, (Bergh. Ann. 2.)
Glatzer Schneeberg,	4300	4586	Charpentier, (Miltenberg.)
Eisthalerspitze ,..	8000	8533	Wahlenberg, Flora Carp.
Lomnitzerspitze, ..	7944	8473	Do. do. do.
Hundsdorfferspitze,	7800	8320	Do. do. do.
Clermont, ...	1265	1349	Ramond, Mem. sur la form. bar.
Gaisekaln, ...	965	1029	Struve, (Bergh. Ann. 12.)
Tschadyrdagh, ..	4742	5058	Engelhard and Parrot, Reise.
Babugan Jaila, ..	4724	5038	Do. do. do.
Orbelos, ...	9000	9600	Poqueville, (Miltenberg).
Mt. Dínario, ..	7000	7466	Hacquet, (Miltenberg).
Klek, ...	6500	6933	Do. do
Mt. Viso, ...	11809	12596	Corabauf, (Mem. de la. Soc. de Geogr. 2.)
Loucyra, ...	13548	14451	Guérin (Miltenberg.)
Montblanc, ..	14798	15786	Roger, (Bibl. Univ. 1828.)
Mt. Rosa, ...	14273	15224	Corabœuf, (l. c.)
Jungfrau, ..	12872	13730	Tralles. Best. der Höhen.
Finsteraarhorn, ..	13234	14116	Do. do. do.
Ortler, ...	12059	12863	v. Welden, Monte Rosa.
Groszglockner, ..	12483	13315	Schiegg. (v. Welden) v. Moll. Jahrbüch, 1800 Mean.
Terglou, ...	9294	9913	Hacquet, (Miltenberg.)
Steiner Alp, ..	10274	10958	Valsoret, (Miltenberg.)
Col de Tende, ..	5739	6121	Schouw MSS.
Col de Genévre, ..	6109	6516	Hericart. Villars. (Journ. de Phys.) Mean.
Mt. Cenis, ...	6446	6876	Schouw, (Zach. Corresp. 1.)
Gr. Bernard, ..	7668	8179	Biblioth. Univ.
Simplon, ...	6198	6611	Hertha, 1.
St. Gothard, ..	6439	6868	Schöu Witterungskunde.
Splügen, ...	6451	6881	Schouw, (Zacch. Corresp. 1.)
Stilfser Joch, ..	8610	9184	v. Welden, Mte. Rosa.
Brenner, ...	4364	4654	v. Buch. Geog. Beob.
Semmering, ..	3122	3330	Fallon. (Zacch. Monatl. Corr. 25.)
Lake of Geneva, ..	1146	1222	Roger. Bibl. Univ. 1828.
Lake of Neufchatel,	1340	1429	Malten, Hertha 14.
Lake of Zürich, ..	1264	1348	Wahlenberg, Tentamen Helvet.
Lake of Boden, ..	1089	1161	Miltenberg.
Lake Cenis, ..	6070	6474	Schouw (Zach. l. c.)
Milano, ...	420	448	Cesaris. Bibl. Ital. 1831. Feb.
Ofen, ...	477	508	Wahlenberg Flor. Carpath.
Geneve, ...	1200	1280	Bibl. Univ.

Names.	Paris feet.	English feet.	Remarks.
Münich,	1629	1737	Schöu. Witterungsk.
Peissenberg,	3088	3293	Do. do.
Vignemale,	10326	11014	Reboul. and Vidal. Ann. de Chim. T. 5.
Mt. Perdu,	10482	11180	Do. do. do.
Pic Posets,	10584	11289	Do. do. do.
Pic Nethon,	10722	11436	Do. do. do.
Mont Calm,	10008	10675	Do. do. do.
Canigon,	8580	9152	Do. do. do.
Mt. Louis,	4890	5216	Cotte Memoir, T. 2.
Madrid,	2016	2150	Bauza & Humboldt, (Hertha 4.)
Granada,	2414	2574	Rodrigues, (Ann. de Chim. 1822.)
Penalura,	7716	8230	Bauza, (Humboldt, l. c.)
San Ildefonso,	3846	4102	Do. do. do.
Pass of Guadarama,	4818	5139	Humboldt, l. c.
Cerre de Mulhacen,	10870	11594	Rodrigues, l. c.
Albujarras,	8700	9280	Miltenberg.
Serra Foja,	3830	4085	Franzini, (Balbi Essai Statistique.)
Silla Torellos,	4802	5122	Miltenberg.
Mte. Toro,	4500	4800	Brúgiere Orographie.
Mte. Cimone,	6645	7088	Inghirami, Elevazione delle princip. eminenze della Toscana.
Alpe di Camporaghene,	6153	6563	Ibid.
Sibilla,	6766	7217	Schouw, (Zach. Corr. 2.)
Gransasso d'Italia,	8935	9530	Do. do. do.
Majella,	8770	9354	Do. do. do.
Mte. Pollino,	7004	7470	Schouw MSS.
La Sila,	5000	5333	Schouw, (approx.)
Aspromonte,	6000	6400	Do. do.
Pizzo d'Uccella,	5771	6155	Inghirami, l. c.
M. Amiata,	5436	5798	Schouw, (Zach. Corresp. Astr. 1.)
Schiena d'Asino,	4547	4768	Prony. Marais Pontins.
Mte. Albano,	2966	3163	Schouw, (Zach. Corresp. Astr. 1.)
Gargano,	3000	3200	Schouw, (approx.)
Vesuvius,	3774	4025	Humboldt. (Hertha 12.)
Euganeans,	1830	1952	Shouw MSS.
Elba,	3097	3303	Piquet. Carte de l'isle d'Elbe.
Stromboli,	2037	2172	Smyth, (Zach. Corr. 10.)
Pass of La Bocchetta,	2367	2524	Schouw, (Zach. Corr. Astr. 1.)

Names.	Paris feet.	English feet.	Remarks.
Pietramala, ..	2996	3195	Schouw. (Zach. Corr. Astr. 1.)
Ariano, ...	2352	2588	Do. do.
Lago Fucino, ..	2047	2183	Schouw, (Zach. Corr. Astr. 2.)
Le Madonie, ..	6111	6518	l. c. Do. do.
Enat, ...	10484	11182	Schouw, Bibl. Univ. 1819.
Genargentu, ..	5632	6007	Marmora Sardaigne.
Mte. Rotondo, ..	8506	9073	Annuaire de la Corse.
Mte. d'Oro, ..	8166	8710	Perney, (Miltenberg.)
Pindus, ...	6500	6933	Holland, Travel.
Taygetus,.. ..	7441	7937	French Engineers, (Berghaus.)
Ida, ...	7200	7680	Sieber, Reise nach Kreta, 2.

Concluding Observations of M. Deshayes, *on the completion of his great work on the Fossil Shells of the Paris Basin.*[*]

Having concluded the description of the fossil shells of the environs of Paris, it will not be altogether useless to take a rapid view of the general results obtained by their study.

All those persons who are now occupied in geological researches, acknowledge how much useful aid they have obtained from a knowledge of organic fossil bodies, which are imbedded in the crust of the earth. We have already said, that they are the authentic medallions by which we are enabled to trace the philosophic history of the successive revolutions to which the planet we inhabit has been subject.

Great results have already been accomplished in the science of geology, and much grace has been conferred on its study by combining it with that of fossils; and these results are almost always obtained by means of appropriate inductions derived from a comparison of the organization of living animals with the remains of the extinct, or fossil species. There can be no doubt geology, although still

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[*] "Description des Coquilles Fossils des environs de Paris, par G. P. Deshayes," &c., *tome second, p.* 763.—Ed.

in its infancy, is far from an art of minor perfection; nor is it confined to enquiries merely of more or less exactitude into the chronology of the ages of our earth, but it also attempts to revive, as it were, the forms that peopled the surface of the earth at times anterior to the existence of man, and of which it is impossible to have any other history than the primitive ages have left us in these ancient medals. It is not alone to determine the periods of mineral changes, which are uncertain in their nature, and of comparatively little philosophical importance; but it is the glory of the geologist, aided by the labours of zoologists and botanists, to collect and arrange materials for the history of each of the great periods during which organic beings were successively developed, and to bring them by a succession of great events, (sometimes interrupted,) down to the period of authentic history.

Cuvier in his *Recherches sur les Ossemens Fossiles*, and M. Brongiart in the example of the great zoologist, have been the first to introduce the study of organic fossils, and Cuvier in particular has afforded, by numerous examples and happy inductions, various beautiful applications of this study to geological pursuits. M. Brongiart afterwards conferred additional value on the study of organic fossils, by extending their application to geological questions, which appeared to him to have remained before without satisfactory solution, and which were capable of illustration by means of those particular organic fossils which formed the peculiar subject of his own study. It is no easy matter indeed to seize for sound geological application, such parts of the science of fossils as are most adapted to the purpose. All branches of the subject are doubtless useful, but all are not so to the same degree; thus for example, the remains of vertebrated animals are rare, and difficultly determined, diminishing rapidly in proportion as we descend, seldom affording results so general as those of other classes. Thus it must also follow from the circumstance of plants being extremely favourable to their preservation, that numerous terrestrial strata will contain some traces of them.

This is no less the case with many classes of invertebrate animals, and among these, shells and zoophytes are the most universally distributed. These bodies are seen in all strata; frequently distributed in great abundance; and their study well attended to, is an immense aid; for they cannot be examined with a view to the great question of their history, without affording exact materials for the solution of the difficult question of the general and physical history of the globe.

To render useful services to the science of geology, it is necessary that zoologists should apply themselves to the minute study of those fossil bodies, which are most universally distributed.

In this point of view, Conchology possesses an incontestable pre-eminence; but it is unnecessary to defend a science, which from the taste and zeal of its amateurs, has recently become a fashionable study, more difficult however than is generally supposed, and only conferring utility in its vast applications in proportion as we descend to its minutest details.

This science, like all the other branches of Zoology, implies an acquaintance with the intimate structure of animals, so as to combine the character and affinities of organization with the form of the solid body which the animal supports. It is after we have become acquainted with all the facts detailed relative to living mollusca, that we can arrive at a rational knowledge of fossil shells by means of inductions sometimes difficult, in which we are guided nevertheless by recent shells.

The inductions are first applied to the fossil species which approach nearest to the living; but in proportion as we descend in the strata of the earth, the species differ more and more from our own, belonging frequently to extinct races of animals; and it is necessary to be able to employ these inductions, so as to verify each step by observation. Thus for example, after obtaining the first results of comparison between the fossil and living species, the former must then be compared with the fossils of different types, and on this process being extended to the whole series of fossil shells, our judgment is to be formed from the result. It is by following those steps of which we are now about to afford a rapid view, and which we have endeavoured to detail at large in this work, that we may hope to facilitate a knowledge of the geology of a set of strata, which will serve as a starting point in the study of tertiary rocks, and at the same time present to the zoologist interesting facts relative to species which no longer exist on the surface of the earth.

From the study of our species of the Paris basin being nearly complete, they afford the hope, after very extensive researches on the subject, that we shall be able to deduce from them a standard of comparison for the study of other tertiary beds in which the same fossils occur.

In a work presented to the Academy of Sciences in 1831, we have given the results of the comparisons which we had made between the shells of living species and the fossil shells of the tertiary deposits of Europe. One of the principal results of this comparison has been the determination of the peculiar characters of these beds, and an indication of their superposition; these results with prophetic spirit appear to have anticipated subsequent acquisitions which have been made to science by the researches of geologists, and it is thus that we have also realised our former conjectures, and have established the importance in these pursuits, of inductions derived from zoological inquiries.

Another result obtained by the same means is, that no one species of shell has been found to belong to both secondary and tertiary strata: thus the upper beds of the secondary, which constitute the chalk formation, are perfectly distinguished from the tertiary strata by means of geological observations, as they are by those of the zoologist. Objections have been made to this result, founded on the existence of beds in which there is an intermixture of species of the chalk with those of tertiary fossils. But we are convinced that this is an error, arising from incomplete observations, and we doubt not, will so appear when these same beds shall have been examined by competent persons without regard to theoretical opinions. Every where in short, not alone in the Pyrenèes, geologists agree in the obvious distinctions between the chalk formation and the tertiary beds.

The Paris basin, placed in a geological series between the chalk and the upper tertiary beds, presents to the researches of the learned a deep interest, from the hope of its affording a solution to questions of great importance. It was natural at first, to compare the species which these more ancient deposits afford with those which are now alive.

But if it be true, as we believe, that the whole of the species of the secondary beds have been destroyed in Europe, at least before the establishment in the same countries of those of the tertiary, we must conceive the chain of succession to have been violently broken, from whatever cause is difficult of explanation. If after a great cataclysm, all the races of marine animals were to be destroyed, how are we to explain the sudden reappearance of the whole of the zoology of the Paris basin, which we have proved to consist of nearly 1200 species, belonging alone to the class of molluscs? These have been well examined in a succession of species and individuals, in order to establish their modifications, and define the limits of the species; but that which we have been unable to comprehend, and which is yet inexplicable to us in the present state of our knowledge, is the extinctions and remodelments of races of animals which have frequently taken place during long geological periods, such as those which we know to have happened in Europe.

The comparison of the species of tertiary beds with those of the secondary, of which we have just now spoken, having afforded the important result that none of the species of the secondary deposits lived at the same time with those of the most inferior tertiary beds, it was curious to examine whether these inferior tertiary beds contained any species which might be identified with those which now live. This identity is incontestably established, but only in regard to a small number of species, which is sufficient, we think, to connect the tertiary epoch with the present, and this connexion is so much more remarkable, as we have seen the number of analogues augment in proportion as we pass from the more ancient to the more recent beds.

Yet within these few years geologists assimilate the whole of these beds, which they believe to be of the same age, and represent them parallel, bed for bed, to those of the Paris basin. But we have seen in the tertiary beds not a parallelism, but a true succession, and at the same time we have made use of the analogy of fossil species to distinguish between them, where they are limited to a very small number of those tertiary basins of the same geological epoch with that of Paris. We have had occasion in the course of this work in giving the localities of the species, to mention two of these tertiary basins which are of the same age with ours; we refer to that of London, and to that of Belgium, as more extensive and considerable than we are in the habit of supposing.

The little tertiary basin of *La Manche,* in the environs of *Volognes;* the calcareous beds of *Bas-medoc,* which are deposited below, and on either side of the vast basin of *Gironde;* on one part of the valley of *Ronca,* near Verona; the limestones of *Castel-Comberts;* the beds singularly modified in the Alps, and which are met with particularly in the environs of *Gap;* belong also to the formations of the Paris basin, because they contain the same fossils. It appears, indeed, that the same fossils are presented again in Hungary and in Moldavia, which announces that the sea from which they have been deposited, was vast and extensive. We may remark, from the observations of others, that traces of the presence of the same sea will be found far more extensive than those we have mentioned. A very important question suggests itself here, as depending on a more careful examination of fossil species; many persons for instance, have been employed in researches relative to the temperature of the earth during the great geological epochs. To arrive at the solution of this question, numerous important things require to be considered, and whatever light we are to hope for on the subject, we believe must result from an investigation of the tertiary beds of Europe, among which those of the Paris basin occupy a principal place; for the question of temperature is inseparably connected with the character of the animals, whose remains are entombed in these strata. And here we have to encounter the only source of difficulty; but when the whole of the phenomena connected with the tertiary strata are examined together, they lend a mutual support to the results. We are now accordingly to afford a brief statement of our opinions on the subject, and of the means by which we have formed our conclusions.

If the character of the plants, as learnedly established by M. Arago, in *L'Anuaire du Bureau des Longitudes de* 1834, enable us to afford an approximation to the mean temperature of periods in which they lived; if the existence in certain places of the vine, palms, &c. be equivalent with the philosopher to thermometric observations, we thus know that the animals, and above all, those which people the waters of the sea, enable us by their presence to determine very nearly the mean temperature of the places they inhabit.

All marine animals are not true indicators of temperature; it is necessary to select for the purpose, those whose feeble movements constrain them to depend for their sustenance on the alternations of the seasons, and compel them to limit their influence to the places where they were first produced. The greater number of the mollusca and zoophytes supply these conditions.

To arrive at the knowledge of the temperature of the times anterior to the existence of man, the logical course to pursue is, first, to search for some positive position to start from, so as to assure ourselves of the real character of the animals from which we derive our evidence, and then to seize upon those conditions of their existence, with which temperature has more or less to do. It is the principal part which temperature plays in the distribution of the mollusca, in advancing to the North or South, which we are now briefly to explain; and for brevity's sake, shall speak only of those which have been collected near Cape North, and in the Gulf of Guinea.

If the small number of species which live in the north be separately considered, they can be divided into two very distinct kinds: the one proper to the colder seas, do not pass beyond the limits of these; the others, in smaller number, coming to live in the temperate regions of Germany, France, and England, with the species of these seas.

In examining the testaceous molluscs of the seas of the temperate regions of Europe in which there exists a greater number of species than in the seas of the north, it is easy to separate them into three series: in the first of these are comprised those which we have indicated, and which return again to the seas of the north; the species of the second series descend into the seas of the south; lastly, those of the third series are proper to European temperatures. If we now carry our observations to the intertropical regions, we meet with similar phenomena; we meet with a greater number of species than in the two preceding regions, and amidst these, some are proper to the temperate region; a great number also proper to the equatorial seas.

These are general facts, and we can already draw from them this general conclusion, that each assemblage of species represents the mean temperature. But there are some species more locally, and others more generally distributed. Thus the *Buccinum undatum,* for example, is found from Cape North to Senegal, slightly modified by temperature; thus it is easy enough to distinguish in it the varieties produced by three or four principal conditions of temperature. This species is not the only one thus distributed, but we are already acquainted with a very considerable number, having with this the property of living in different temperatures.

Other species more sensible of the influences of temperatures, are much more local, and are those which it is important to understand. I here enumerate some of them :—

1. *Buccinum glaciale.* It does not extend beyond the polar circle, and is found in Norway and Greenland.

2. *Cardium grœnlandicum.* With the preceding.

3. *Terebratula psittacia.* Between 65° and the 75°; these species, and many others which it would be too numerous to mention, represent the mean temperature of the north of Norway.

1. *Tellina baltica.*
2. *Patella noachina.*
3. *Natica clausa.*
4. Many species of the genus *Astarte.*
5. *Patella testudinalis,* etc.

These and other species represent the mean temperature of the north of England, south of Sweden and of Denmark. In the British Channel, on the coasts of France and England, there also exist many species peculiar to our temperature.

1. *Pholas callosa.*
2. *Psamobia vespertina.*
3. *Pecten irregularis,* etc.

The coasts of Spain and Portugal are less known than those of New Holland or South America.

The Mediterranean contains also a great number of species peculiar to it; but as this is an inland sea, we will not now speak of it, lest we should attribute the presence of its species to peculiar circumstances.

The observations are few in number on the coasts of Africa, from Barbary to Senegal; but for this important region, we have the excellent work of Adanson, and the commercial relations with Senegal and Guinea have long since enriched the collections of marine shells from this quarter.

Amidst the great number of species known in the intertropical zone, there are many which are peculiar to it, but the list is too long to enter into the particulars in this place. The species inhabiting warm climates are less variable, nor are they met with living on any other part of the surface of the globe; they determine therefore with fidelity the temperature of the sea they inhabit.

These facts are mentioned as concisely as possible, that they may precede what we have to say on the temperature of the geological epochs of the tertiary strata; but to afford a solution of this interesting question, it was necessary that the whole of the living species with which we are acquainted, should be compared with patience, care, and minuteness, with all those that are found in the different tertiary beds of Europe; and here are the principal results obtained by our labours on this subject:—

1. The tertiary beds of Europe do not contain any one species identical with those of the secondary rocks.
2. The tertiary beds alone contain species still living.
3. The analogues of living species are more numerous in proportion as the bed is more recent, and vice versa.

4. The constant proportions (3 per cent. 19 per cent. and 52 per cent.) in the number of living species determine the age of the tertiary beds.

5. The tertiary beds are in superposition, and not in parallellism as had been supposed.

6. The beds, from their zoological contents, appear to be divided into three groups or stages.

About the month of August 1831, we proved the existence of these groups, and indicated the places where the observations were made; geologists have since confirmed these results, and separated the tertiary rocks accordingly.

The latest and most superficial tertiary strata have been deposited when the temperature of Europe was almost the same as it is at present; here are the proofs.

The tertiary beds of this age, of Norway and Sweden, of Denmark, of Saint Hospice near Nice, of a portion of Sicily, contain in a fossil state, all the species of the corresponding seas, and amongst others, those which in most places best represent for us the temperature. These fossils present the same series of varieties with the living species which announces most positively, that the beds referred to have been deposited under circumstances similar to those in which their existence is still maintained. These same beds in the South of France, subject to the Mediterranean, of Spain, of Italy, and of Sicily, of the Morea, of Barbary, (Algiers,) contain a large proportion of the species still living in the Mediterranean, but they contain also those whose analogues do not exist, or are distributed in small numbers in the warmer regions of the Atlantic, and the Seas of India. To afford a correct idea of the tertiary period in Italy, we must distinguish three sorts of fossil species.

1. Those whose analogues are still living in the Mediterranean.

2. Those in small number, whose analogues are not found

in the Mediterranean, but in the Atlantic Ocean, the Red Sea, and the Seas of India.

3. Those of which no living analogues exist.

These observations we have made, thinking that the Mediterranean had been selected for trial on an insufficient basis on account of the chain of the Atlas mountains on one coast, and that of the Apennine on the other, affecting the temperature. These changes in the elevation of strata, and consequently of temperature, explain the extinction of the living analogues of a certain number of fossil species on the sides of the Mediterranean, and the distribution of certain others in warmer seas. To us it appears probable, that the Mediterranean before the last movements of its borders, had one large open communication with the Atlantic Ocean through the great desert of Africa, and another with the Indian Ocean, which may have been either by the Red Sea, or by the flat sandy parts of Arabia, which separate the Mediterranean from the Persian Gulph.

The second tertiary period composes a great number of little basins; as the *Superga*, near Turin; the basin of the Gironde; the marine deposits composing the *faluns* of Touraine; the little basin of Angers; the basin of Vienna in Austria; the *Pódolia;* the *Volhinia;* and some other patches on the southern frontier of Russia in Europe; patches, whereof some spots are seen not far from Moscow. The lacustrine beds of *Mentz*, and the borders of the Rhine, also probably belong to this period.

The duration of this period we do not know, but it has been considerable, for not only have the deposits formerly composed a large surface, but they have still in many places a great thickness. During this period, the temperature has been very different from that which we now experience; indeed the species proper now-a-day to Senegal and the sea of Guinea, those which represent the mean temperature of the tropics, correspond with the fossils in the several places we have mentioned. Now, considering the number of species, and the great number of individuals belonging to each of these, their development would suggest the basin of the Gironde as the line of greatest intensity of heat, where in former times an equatorial temperature prevailed; it has necessarily been to this temperature that we owe the present fossil remains of species, which in former times inhabited our seas. It was necessary that this increased temperature should also have been directed continuously during a long series of cycle, in order that the accumulated constituents of generations should form by their remains a solid of such vast expanse.

If, as we firmly believe, the basin of Gironde to have been deposited under an equatorial temperature, it will be sufficient to cast a look at a map in order to feel convinced that the influence of this temperature has extended as far as Poland, and to the middle of Russia in Europe.

To determine the equatorial temperature of our second tertiary period, we have compared nearly two hundred species of the intertropical zone with the fossil species from the upper strata at Bourdeaux and Dax, and other basins belonging to this second period; but unfortunately one conclusive element is deficient for the first tertiary period, that which represents the Paris basin. In nearly fourteen hundred species, thirty-eight only have living analogues; it is true that the greater number of these species are found throughout the equatorial zone, but among them there appear to be some, which are found not only in that zone, but which pass into our temperate seas, and even wander to the North Sea.

I must therefore abandon, in regard to the most important tertiary period, those means for the estimation of its temperature, which have been employed with success in the case of the two preceding periods. We endeavour in the mean time to supply by several indirect means, the want of direct means of comparison which we here experience.

In the frozen seas, there exists but a small number of molluscs; but some species are adapted to endure cold in proportion as they advance from the warmer regions, and thus there are but eight or ten, which subsist at the 80th degree, while there are above nine hundred living species in the tropical region of Senegal and Guinea. This augmentation of species with temperature, sufficiently indicates the powerful agency of heat in the creation of these beings. But this phenomenon is not alone seen in those parts of the terrestrial globe which we have selected for example, it is repeated from the sea of Behring to the isles of Sunda, and may be traced inversely on each coast of South America.

One important fact is elicited, and affords a new *point d' appui* in the estimation of the temperatures of these last tertiary periods; it is the proportion in the number of fossil and of the living species. Thus in northern latitudes, few species exist, and few of those which do, are found fossil; of tropical regions nearly seven hundred species are fossil, and six hundred exist. It must be remembered, that this difference in the proportion of the living as compared with the fossil species, is owing to a certain number belonging to lost races. In short, the elevated temperature of the second period may be regarded as settled with certainty, when we state, that nearly one thousand species in the corresponding basins have been examined and compared with nine hundred living species from the intertropical seas of Africa.

Since the number of species accords with the temperature; since, on one particular portion of the intertropical region we find nearly nine hundred species, it appears to me natural, that we should attribute to the first tertiary period a temperature at least equatorial; for we are actually acquainted with fourteen hundred species, of which twelve hundred were collected in the Paris basin, that is to say, in an extent of forty leagues in diameter in one direction and fifty-five in another, there do not exist in any of our seas any thing approaching to so many species in a space so limited.

If we now examine these species, we shall find particularly large numbers of them to belong to those genera and families, the species of which are so numerous in the warmest regions of the earth. One hundred and forty species of the genus *Cerithium*, a great number of the genus *Fussus*, of *Pleurotoma*, of *Mitra*, of *Voluta*, of *Venus*, of *Buccinum*, of *Arca*—fossils of the environs of Paris. The absence in this basin of the forms proper to the northern seas, all the considerations connected with Conchology, unite in attesting strongly the great period of time the Parisian strata required to form, under a temperature probably more elevated than that of the present equator.

In adverting to others parts of the Parisian Paleontology not belonging to Conchology, we find in the great number of *Pachydermata*, their size sometimes gigantic, a proof of the high temperature of the Paris basin. Where do we find in the present day analogous animals, if it be not in the tropical parts of Africa and South America, in the islands of Sunda, and in those of Asia? In addition to these considerations, those which are furnished by a small number of plants, particularly palms, sufficiently prove the high temperature of the period during which the first tertiary deposits took place. We might here be able to form a contrast between the ancient condition of the Paris basin compared with its present state—we might find on one side a great number of animals of which the races have become extinct; on the other, the soil occupied by the races of recent animals, and the seas in the vicinity peopled with species of which ninety-nine *per cent.* did not exist in former times. We should see in this comparison the proofs of the wonderful changes which are in operation in the conditions of the existence of living beings; but we will not urge this interesting subject, which demands more attention than we could devote to it in this place.

The details we have gone over, appear to lead to the following conclusions:—

The first tertiary period must have rolled away under an equatorial temperature, in all probability, many degrees warmer than that of the present equator.

During the second period, the deposits of which occupy the centre of Europe, the temperature has been similar to that of Senegal and of Guinea.

The temperature of the third period was at first a little higher than that of the present basin of the Mediterranean, it then became, as we have endeavoured to shew, fixed or uniform: for in the north, the species of the north are fossil; in the south those of the south are fossil.

Thus we have established the fact, that since the commencement of the tertiary beds, the temperature has been constantly diminishing: the theory of the central heat of the globe, which rested on the supposition of philosophers, rendered the change of temperature, of which we have been speaking, probable; but it is curious to see a science long neglected approaching these important questions, and furnishing materials calculated to explain them.

The question of temperature is not the only domain of Zoology and Conchology in particular, its use extends to other subjects of no less importance, connected with the development of life on the surface of the earth, throughout time and space, in proportion to the extent of its materials; but this science is yet in its infancy. Lamarck has drawn the outline; who is to lay the foundation?

We have long since remarked, and we continue to repeat, that Geology had no claim to the character of an exact science until the moment when she adopted those branches of philosophy which treat of organic beings, their investigation from the nature of the subjects being more within a rational controul. It will now be understood, after what we have elsewhere said, that Zoology is the basis of Geology, and that there can be no science in the latter beyond what it owes to organic remains, and of this truth, we are therefore every day more and more convinced.*

The Silurian System. By R. I. Murchison, Esq., F.R.S., F.L.S., &c. &c. &c.

[Continued from vol. i. p. 527.]

We know of no elementary work in which the entire succession of strata, from the most ancient to the recent deposits are exhibited in a connected view, so as to include the results of recent observations. The rocks beneath the old red sandstone have been fully investigated by Mr. Murchison, who has pointed out a regular series of strata beneath the old red sandstone, distinguished by the

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* Nothing can exemplify more forcibly the truth of the concluding observations of M. Deshayes, than the following analysis of Murchison's *Silurian System,* except indeed the original work of Mr. Murchison itself, which, like that of M. Deshayes, is unfortunately inaccessible, from its size and expense, to the generality of readers, particularly in India. Many instances of the practical importance of organic fossils in directing enquiries for coal and other useful minerals, will be found throughout our notices of Mr. Murchison's work; but it is only necessary to refer the reader to vol. i. p. 18 of this Journal, to be convinced of the importance of fossil remains as the only sure guide in all enquiries connected with the subject of Geology, whether theoretical, or practical. The retrograde movement recently made in the Asiatic Society of Calcutta in the Patronage of '*Economic Geology*' is therefore much to be regretted, however we may be disposed to acknowledge the importance to engineers and architects of the art of selecting materials; but to call this '*Geology,*' and to pretend that it is capable of facilitating our knowledge of the productions of a country, is to say the least of it, erroneous.

presence of peculiar organic remains, the first strata of which are connected by a gradual advancement in the number and characters of their fossil contents with newer deposits. Some of these beds were known, others were either not known, or mistaken for rocks connected with, or belonging to the coal measures.

The *upper Silurian*, or Ludlow formation, consists of red and yellow compact micaceous sandstones, bluish grey mottled limestone, and slaty impure argillaceous slates containing lime and sandy particles. The upper stratum of Silurian rocks, where it dips beneath the old red sandstone, is covered by the remains of large fish bones, shells, and coprolites, called the bone bed. The remains contained in this bed partake equally of those forms, (chiefly fishes,) which are found in the upper Silurian, and lower old red system.

Below these strata, the rocks generally lose the appearance of sandstone, and contain more calcareous matter, which is mixed up mechanically in an argillaceous paste.* The strata are usually thin bedded, but are not so compact as to answer for flagstones. The surface of the beds present a waved undulating appearance, like the ridges and furrows occasioned by the rippling action of waves, to which the appearance is partly due. Mr. Murchison, however, thinks some of the transverse markings have been occasioned by animals, such as lived on sandy shores. The animals whose remains characterise these upper beds, are *Leptæna lata*, t. vii. fig. 15, *Cypricardia amygdalina*, t. vii. fig. 3 *Orbicula rugata*, t. vii. fig. 19, and *Avicula lineata*, t. vii. fig. 18, which also occur in the lower beds of the old red system.

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* These stones are used for building, but they do not answer well, unless when used immediately after extraction from the quarry, when they require to be laid horizontally in the direction of their slaty laminæ.

Serpuloides (?) *longissuna,* t. vii. fig. 1, and of Crustacea, *Homalonotus knightii,* (König.) t: viii. fig. 9, 10,* and *H. Ludensis,* Murch. t. viii. fig. 11, *Orthocerus Striatum.* Some beds contain a small species of Turbo, T. coralii, invested often with a species of coral, *Favosites fibrosa,* Gold fuss. The third stage of the upper Silurian rocks becomes micaceous, and more argillaceous, occasionally running into large spheroidal concretionary forms; these beds contain fewer organic remains, but the lowest beds of this division are characterised by a species of *Terebratula, T. navicula.* t. vii. fig. 16.

Ludlow or Aymestry Limestone.—The beds just described are occasionally called the mudbeds, from their loose friable structure. They are succeeded by a subcrystalline argillaceous blue, or bluish grey limestone of laminated structure, produed by shells and corals. The characteristic fossils of these beds are, *Pentameris Knightii,* t. viii. f. i. a. (fig. 1, b. the young.) *Lingula Lewisii,* t. viii. fig. 4, *Terebratula Wilsoni, Bellerophon Aymestriensis,* t. viii. fig. 5, *Avicula Reticulata,* t. viii. fig. 6; and corals, *Favosites Gothlandica.* t. viii. fig. 7, 8, *Atrypa Affinis, Terebratula Affinis*; but where the latter become characteristic, *Pentamerus Knightii* disappear. These limestone beds are distinguished by the name of the place where they were first discovered by Mr. Murchison, are much less pure than those of the mountain limestone, but their earthy character renders them of great value, as affording a cement which sets in subaqueous operations. Crystals of carbonate of lime and sulphate of barytes are the only minerals observed by Mr. Murchison in this limestone.

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* We have selected from the numerous plates in Murchison's work, figures of a few of the most characteristic fossils, of which we have compiled the plates referred to in the text, in order that these remarks, in the absence of the original work, may be more intelligible and useful to observers in India.

Lower Ludlow Rock.—Beneath the latter beds, calcareous thin bedded flagstones occur; the strata seams are formed by thin layers of sandstone; occasionally a substance like fuller's earth occurs between the beds. The colour of the rock in situ is dark grey or black, but it weathers, like all similar beds of the upper Silurian system, to light ashen grey. These beds are distinguished by many peculiar organic remains, which have not been observed in any overlying stratum, viz. *Cardiola interrupta, Phragmoceras Nautileum,* t. viii. fig. 12, 13, *Orthocerus filosum, O. Pyriforme,* t. viii. fig. 2, *Lituites giganteus,* together with Trilobites, as *Calymene Blumenbachii* and *Asaphus caudatus,* but these last fossils are equally found in the subjacent beds. With the exception of thin seams of galena, and a little iron pyrites, no minerals have been found in this rock. The entire thickness of the Ludlow rocks is estimated by Mr. Murchison at 1,500 feet.

Wenlock Limestone, or Ballstone. The next member of the Silurian system corresponds with a limestone which projects abruptly through the coal formation at Dudley, where the intermediate beds being wanting, it was impossible to ascertain its place in the geological series. This limestone is distinguished by its containing masses of a crystalline limestone, highly charged with corals and encrinites, so much so, as to be liable to be mistaken for mountain limestone; but on further enquiry, it is found, that the crenoidal remains contained in this rock are peculiar to itself, or at least distinct from those of the mountain limestone. The ordinary colour of the rock is dark grey, freckled with veins and strings of white carbonate of lime. The beds are broken and irregular, with deposits of shale contained in the crevices. This last is so abundant, as to give the limestone an earthy appearance, and to constitute one of the best characters of the rock. In other cases, all traces of bedding are wanting, and the whole calcareous mass is made up of concretions called ballstones,* sometimes of immense size, surrounded by beds of shale and impure limestone.

Beneath these beds, a shale containing concretions of very impure limestone occurs. These beds, which are called Wenlock shale, constitute the base of the upper Silurian rocks. These beds are succeeded occasionally by courses of very impure lenticular limestone, the concretions of which contain concentric figures, made up of dark coloured crystalline carbonate of lime in an argillaceous paste.

The Wenlock portion of the upper Silurian rocks is estimated by Mr. Murchison at about 1000 feet in thickness; that is, 300 feet for the limestone, and 700 for the beds of shale.

The minerals found in it, are calcspar, sulphate of barytes, lead and iron, peroxide of manganese, sulphurets of copper and bitumen, but not in such abundance as to render any of them of much value.

The organic remains on which the peculiarity of this rock depends, consist of

CORALS.

Heliopora pyriformis, (De Blain.)
Catenipora escharoides, (Lamarck.)
Stromatopora concentrica, (Goldf.)
Favosites Gothlandica, (Lamarck.)
Cyathophyllum turbinatum, (Goldf.)
Simaria clothrata, (Steininger.)

CONCHIFERS.

Euomphalus discors,
——— rugosus.
——— funatus,
Productus Euglyphus,
——— depressus,

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* These are used as a flux for iron ore, and preferred, Mr. M. remarks, to the impure limestone.

Atrypa tenuistriata,
——— aspera,
Terebratula imbricata,
———— cuneata,
Nerita haliotis,
Orthoceras Brightii,

TRILOBITES.*

Asaphus caudatus,
Calymene Blumenbachii,
Common to the Ludlow and Wenlock beds.

Calymene variolaris, Parkin
——— *macrophthalma,* Brong.
——— *Downingiæ,*
——— *tuberculata,*
Asaphus Stokesi, Murch.
——— longicaudatus, id.
Bumastus Bariensis, id.
Paradoxides bimucronatus, id.
———— *quidrimacronatus,* id.
Peculiar to the Wenlock formation.

The shale of the Wenlock formation is also distinguished by

Productus transversalis.
Spirifer cordiospermiformis,
——— trapezoidalis,
Terebratula brevirostra,
———— interplicata,
———— imbricata,
Orthoceros attenuata,

The following are common to all the Silurian rocks:—

Atrypa affinis.†
Productus depressus, var. pl. 12, fig. 2.

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* Examples of these fossils shall be figured in future numbers when we arrive at that portion of the work in which they are described in detail by W. S. MacLeay, Esq., they are of the more interest, as none have as yet been discovered in India.

† Terebratula affinis, Sow. Min. Con.

THE LOWER SILURIAN ROCKS.

Caradoc Sandstone.—Unlike the upper Silurian rocks, these are composed essentially of sandstone of different colours, with an occasional thin bed of impure sandy limestone. In these beds, all traces of the Trilobites common to the upper Silurian rocks are lost, and in place of them occurs *Trinucleus caractace,* Murch., which belongs to a genus never observed in the upper Silurian rocks. The upper group of this division of Silurian rocks is described by Mr. Murchison as thinly laminated sandy shale, only slightly micaceous, containing layers of pipe clay and thin bands of impure sandy limestone. The fossils characteristic of these beds are,

Productus sericeus,
Bellerophon bilobatus,
B. acutus,
Littorina striatella,
Orthis alternata,
——— callactis,
——— canalis,
——— pecten,
Avicula obliqua,
Arbicula granulata.

The upper beds of this formation dip beneath the Wenlock shale, and the lower strata graduate into flagstones. On fracturing these flagstones, Mr. Murchison remarks, the fossils stand out in neat casts covered with brown and yellow hydrate of iron, presenting a marked relief from the dingy yellow olive green sandstone.

The characteristic fossils in this group of flag strata are,

Orthis actonia,
O. grandis,
Trinucleus caractace,
T. fimbriatus.

This group of Caradoc sandstone, Mr. Murchison thinks, is not less than four hundred feet thick. The flags are in some places worked for troughs, tomb-stones and building purposes.

The calcareous grit forming the lowest bed of the Caradoc formation, contains

Terebratula (orthis) anomala,
Pentamerus oblongus, and the plumose Coral,
Calamopora fibrosa, Goldf.

The Caradoc sandstone reposes on deep reddish purple sandstones, with streaks of dirty yellowish-green, in beds from six inches to two and three feet. Where these beds are exposed, Mr. Murchison found in their superficial strata casts of

Orthis flabellulum,
O. vespertilio,
Terebratula unguis,

These beds are dissimilar to any of the overlying strata from their red colour and intermixture with clay and marl. In other situations, the section of these lower Silurian rocks present

> "Grits and coarse sandstone of brown and yellow colour. Pure white grained sandstone, consisting of grains of sand imbedded in a matrix of felspars, which decomposing, give the whole a freckled appearance. Yellowish sandstone with ferruginous streaks, deep red sandstone, and whitish gritty sandstone."

These sandstones are in places cut through and thrown into vertical position by eruptive trap rocks. In other situations, quartzose pebbles are held together by a ferruginous cement. This formation is liable to be mistaken for old, or even new red sandstone; but its best distinction, says Mr. Murchison, consists in its position below the upper Silurian rocks, and in its organic remains, which are different from those of any formations that overlie it.

The minerals which occur in the lower Silurian rocks, are green carbonate of copper, and other copper ores, thin seams of galena with associated crystals of blende; and where the beds are much disturbed by trap rocks, rich and productive lead veins are found.

The following is a general list of the fossils of the lower Silurian rocks:—

Arca Eastnori,
Avicula orbicularis,
——— obliqua,
Atrypa (Spirifer) crassa,
——— undulata,
——— lens,
——— plana,
——— globosa,
——— polygramma,
——— orbicularis,
——— hemispherica,
——— affinis,
Bellerophon trilobatus,
————— acutus,
————— bilobatus,
Bucinum (?) fusiforme,
Euomphalus tenuistriatus,
————— perturbatus,
————— corudensis,
————— funatus,
Lingula attenuata,
Leptæna* (Producta) sericea,
———— complanatus,
———— duplicata,
———— englypha,

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* Atrypa, Leptæna, and Orthis, are subdivisions of the great genus Terebratula. Leptæna are distinguished in little from the genus Producta. Atrypa are Spirifers, with a short hinge, and destitue of foramen, or having a small triangular one; and with acute, not perforated beaks.

Orthis is distinguished from Spirifer, by its long narrow hinge and circular flat striated shell.—Ed.

Leptæna depressa,
——— tenuistriata,
Littorina striatella,
Lituites cornuarctis,
Nautilus nodosus,
Nucula (?) lævis,
Orbicula granulata,
Orthis grandis,
——— expansa,
——— alternata,
——— compressa,
——— protensa,
——— anomala,
——— pecten,
——— semecircularis,
——— flabellulum,
——— virgata,
——— radians,
——— costata,
——— actoneæ,
——— callactis,
——— lata,
——— triangularis,
——— canalis,
——— testudinaria,
——— bilobata,
——— vespertilio,
Pentamerus lævis,
——— oblongus,
Pleurotomaria angulata,
Spirifer radiatus,
——— plicatus,
——— alatus,
——— liratus,
——— lævis,

Terebratula furcata,
——— unguis,
Terebratula neglecta,
——— tripartita,
——— decemplicata,
——— pusilla,
Tentaculites scalaris,
——— annulatus.

Llandeilo Flags.—The lower strata of Silurian rocks consist of flags, named by Mr. Murchison like the other formations from the place in which he found the strata best developed. They consist of hard, dark-coloured flags, sometimes slightly micaceous, frequently calcareous, with veins of white crystallized carbonate of lime. These beds are, however, better distinguished as the repository of large Trilobites, called *Asaphus Buchii,* Bron. and *A. tyrannus,* Murchison. These flags pass under ridges equivalent to the Carodac, and are seen in some situations to graduate downwards into the older strata of the Cambrian or primary rocks, the upper portion of which consists of overlying masses, containing a few calcareous courses, with casts of fossils, and at intervals thick and massive bands of prophyritic trap, as well as thinly laminated yellowish green bands of compact felspar, and other rocks of igneous origin. Among the fossils found in these beds, Mr. Murchison enumerates the following:—

Orthis anomala,
——— actoniæ,
——— canales,
——— compressa,
——— flabellulum,
——— lata,
——— pecten,
——— protensa,
——— testudinaria,

Bellerophon bilobatus,
Leptæna sericea.

As these fossils also occur in the lower Silurian rocks, no zoological division can yet be drawn between the lower Silurian and upper Cambrian groups.*

And as great lines of disturbance generally mark the frontier of the two groups, the difficulty of defining their common boundary is much increased. On the line of demarcation may occasionally be seen the various Silurian rocks, and the quartzose slaty sandstone passing into a coarse grit, or greywacke of foreign geologists; usually grey, but it is sometimes brownish and other ferruginous colours, and containing casts of encrinites and corals, but in general void of fossils.

The lower flags of the Silurian system (in those situations in Wales where the junction is not interrupted by intrusive trap, as on the western sides of the Grongar hills,) rest on black schists, which overlie the Cambrian strata. These schists are considered by Mr. Murchison and Professor Sedgewicke, as the link that connects the Silurian and Cambrian systems. Mr. Murchison remarks, that the trilobites and fossils of those beds bear so near a resemblance to those described by Mr. Brongniart, from Angers in France, that he regards the black flags in both places as the same.†

Although the upper Cambrian rocks do contain fossils in some places, in Caermarthanshire they do not. Even in those places in which fossil remains have been found, it is not in the fine slaty beds whose structure is so well calculated to preserve organic fossils that they occur, but in occasional courses of hard grits or sandstones, which re-appear at wide intervals in the schist.

These greywacke rocks, or grey micaceous slaty sandstones and compact regenerated slates, often containing fragments of older rocks in a quartzose cement, are gene-

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* Murchison's Silurian System, p. 308.

† Silurian System, p. 358.

rally highly inclined at their junction with Silurian rocks, indicating a period of great physical changes to have elapsed between the time they were consolidated and the commencement of Silurian deposits.

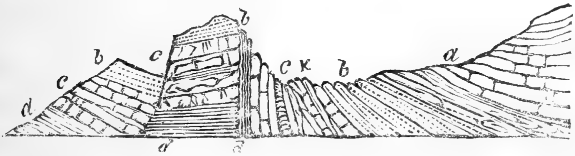
Trap and altered Silurian Rocks.—Great outbursts of trap rocks took place during and after the accumulation of Silurian rocks. Mr. Murchison describes tracts of Caradoc sandstone cut and thrown up into vertical beds in a state approaching to quartz rock, being much indurated, and in parts cellular. Where the sandstones come in contact with trap, it is only to be detected in the state of true quartz; in most instances, the traces of bedding being quite destroyed. Trap rocks when erupted in contact with schist, convert it into an indurated form, or Lydian stone; of this there are several instances, vide Murch. p. 320, where the schist has been originally perhaps of bituminous character, as shale; anthracite is not an uncommon mineral in the altered rock. Mr. Murchison details an instructive instance of this nature, where a credulous farmer ruined himself by mistaking one of these indications of anthracite in the lower Silurian rocks for coal.

Greenstone often contains fragments of the rocks through which it is projected in a state more or less altered; sometimes black crystals of carbonate of lime, iron pyrites, and little flakes of anthracite and mineral waters; when these issue from contiguous springs in volcanic districts, they are often very different in their nature, but when issuing from greenstone they are generally sulphureous and saline.

The older Silurian rocks are covered, in certain localities described by Mr. Murchison, with stratified sedimentary rocks, alternating with nodular concretionary deposits, which he regards as volcanic grit, proving that repeated igneous action took place during the period when the upper Silurian strata were accumulating.

In some instances stratified trap rocks, consisting of concretions of compact felspar, containing crystals of common felspar, hornblende, and iron pyrites, with a little disseminated lime alternate with flags, containing *Asaphus Buchii*, and other trilobites of the lowest beds of Silurian rocks. The beds of volcanic and sedimentary rocks are conformable, one above the other, indicating so many distinct alternations of volcanic and sedimentary deposit. From evidence of this nature, Mr. Murchison has shewn, that submarine volcanic eruptions were frequent during the formation of the lower Silurian beds, while the upper Silurian rocks and old red sandstone were formed during a long period of tranquillity, after which, these last deposits were dismembered and thrown up by vast outbursts of intrusive trap. Mr. Murchison is further led to the conclusion, that the carboniferous system was deposited in vallies after the older strata had been upheaved, and that subsequent dislocations, including some of the most violent with which we are acquainted, took place after the accumulation of the coal measures and lower new red sandstone. How far these conclusions may be borne out, or modified by the observations of geologists in other parts of the world, we are not yet prepared to say; but we feel strongly impressed with their general accuracy in regard to geological facts in India.

The following examples of the dislocations of Silurian rocks in Wales, are given by Mr. Murchison. The first is a complicated fault by which a mass of Aymestry limestone(*c*) has been thrown into nearly vertical position abutting against the edges of a mass of similar limestone, which has been thrust up between the highly inclined strata and another dislocated mass. Each of these bands of limestone (*c*) is capped



by the stratum charged with *Terebratula navicula,* and underlaid by the Pendle beds *(d)* of the lower Ludlow rock.

The locality in which this fault occurs in the Silurian rocks, is situated between two great axes of volcanic outburst, the Dee Hills and the Caradoc, to which this and other similar dislocations in the same district may be ascribed.

One of the effects of sudden outbursts of volcanic rocks, amidst consolidated strata, is to separate the latter; if this be at the same time accompanied with great elevatory movements, large masses of the disturbed strata are liable to give way and become detached. These Mr. Murchison calls outliers. It is always necessary to be able to distinguish outliers, since they are often associated with formations to which they do not belong. Their investigation also, is calculated to throw much light on the circumstances under which the causes which produced them took place. Three outliers of the Ludlow rocks are described by Mr. Murchison; one of these, called Tinker's Hill, rises on the south-west bank of the Teme. It consists chiefly of small nodules imbedded in sandy calcareous shale, occasionally united into flag-like beds of bluish grey earthy limestone, containing *Terebratula Wilsoni,* and other characteristic fossils of the lower Ludlow rocks. This outlier is two miles in length, and is parallel to the main direction of the Silurian deposits.

The direction of the joints and fractures of strata is also an important point, on which subject the reader is referred to Phillip's Geology. In some chains, Mr. Murchison remarks there are long fissures, either coincident with the line of elevation, or nearly at right angles in the direction of the dip. These may frequently, Mr. M. remarks, be ascribed to the elevation of strata *en masse;* but must not be confounded with the symmetrical lines by which beds of rock are often intersected, and which are often the greatest convenience in quarries; for where these straight chinks cut the rocks across their bedding, there is little more to be done than remove the detached masses, as these fissures are unattended with any displacement of strata. They are ascribed to one of the last changes to which the strata affected by them were exposed after their deposit. Crystalline forces have been supposed by Professor Sedgwicke to have had some effect in producing such fissures as these, as well as the slaty cleavage of rocks. Mr. Murchison, however, thinks that such joints in strata have been occasioned by heat, particularly as they seem to be more frequent in the vicinity of fissures of eruption, and particularly in those strata that have been altered by the effects of heat.

Landslips of the Silurian Rocks.—These are referred by Mr. Murchison to the jointed condition of the strata, and their inclined position on the surface of steep ridges, together with the softening or decay of subjacent beds.

Wells in Silurian Rocks.—The jointed structure of the strata already noticed, renders them permeable to water, while, faults, dykes and dislocations act as dams to it, and thus it is obliged to find some other outlet, thus also lines of faults are often traceable by the outburst of springs; singular springs of this kind are referred to by Mr. Murchison, of which every mountainous tract may afford instances. Mineral springs depend on similar causes, the peculiar properties of their waters being derived from the strata through which they permeate.

Mining Ground of Silurian Rocks.—This is situated in the altered rocks, where they come within the influence of trap. Several veins of galena, common and steel grained, are worked; also carbonate of lead, both crystallized and stalactitic. The veins are chiefly parallel to the strike of the strata; but some are in the form of the letter N. Nearly all the veins diverge in separate strings; many of the best and richest ores being found in the points of intersection. The ordinary ores yield from six to seven ounces of silver per ton. Some of the veins were first worked by the Romans, whose mining implements are found in them. In one of the principal veins, says Mr. Murchison, the wall is granular felspar, with green earth; and two contiguous bosses of crystalline greenstone rising up unconformably through the strata of sandstone and shale, *cut* off the productive veins. In this case, Mr. Murchison is of opinion, that there has not been a sufficient quantity of contiguous sandstone and shale to afford *ground* for the production of the ore. The altered rocks in which the only instances of metalliferous veins occurred to his observation throughout the Silurian rocks, were situated in the vicinity of intrusive trap, and that the best veins of galena were found in the lower Silurian rocks near the great outburst of trap. In the shales and sandstones connected with the altered rocks in which the veins of galena are situated, Mr. Murchison found Trilobites,* identical with those of the lowest flags of the Silurian system, together with many shells of the Caradoc sandstone, and thus even in altered disrupted strata he was able to discover the true nature of the rocks in which metallic veins occur in distant situations.

Three of the lead mines situated in lower Silurian rocks of Shropshire, described by Mr. Murchison, near the village of Shelve, afford the following produce:—

Bog mine, ...	1,554 tons of lead,
Snail batch, ...	1,300, ditto,
Grit and gravel mine,	685, ditto.
Total,	3,539

The present depth of the engine shaft of the Bog mine is 293 yards, and the lowest working level 265 yards, the upper working above the adit or boat level 105 yards. In this district, Mr. Murchison observes, there are thirty veins that have been profitably worked.

The Stiper Stones, is a barren naked ridge of quartz rock

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* In a future number we hope to give examples of these curious fossils from Mr. Murchison's work.—Ed.

or altered sandstone, which has been thrown up like a wall between two mining districts, the one affording copper and the other lead ores.

Agricultural character of the Silurian Rocks.—The upper Silurian rocks, when not covered by transported materials, afford a good substratum of clay and sand, owing to the jointed and fissured character of the strata; the soil is dry, the water having once passed through the thin covering of earth enters the rocks, and is thus carried off from the land, which notwithstanding affords good crops of barley, oats, and turnips, as well as good timber.

On the other hand, the second division of the upper Silurian rocks, called Ludlow and Wenlock formations, being soft and argillaceous, and subject to the drainage of water, are comparatively cold and unmanageable, except where limestone rocks afford an intermixture of calcareous matter, which yields excellent crops of wheat.

The lower Silurian rocks afford quite a different character. These rocks being for the most part of a sandy structure, disintegrate into short, not very productive soil; but where the quartzose conglomerates prevail, the surface is sterile. The lowest portion of these rocks consisting of flags, is often, as might be expected from the nature of the beds, rich and productive, particularly in Cærmarthenshire, although where much invaded by trap rocks, as in the mining vicinities of Shropshire, the soil is generally poor.

Lowest Fossiliferous Beds.—As the series of strata extending from the old redstone down to the non-fossiliferous slates has been until lately regarded as a single group, exhibiting the remains of the earliest animals introduced upon the earth, we cannot appreciate too much investigations which are calculated to extend our views to periods so remote as those which the earliest fossiliferous strata refer to. Professor Jameson we believe to have been one of the first observers who discovered the elements of distinct formations between the old red sandstone and non-fossiliferous slates, and the two groups, which he named the older and newer transition rocks, would appear to refer to those divisions of Silurian strata the peculiarities of which have been so well illustrated by Mr. Murchison in the great work before us. In the Plinlimon, or dark and indurated slaty sandstone, which forms the intermediate beds between the Silurian rocks of Murchison and the Cambrian system of Professor Sedgwicke, no fossils have been found, while nearly all those of the 'Bala' or dark limestone overlying the Cambrian or primary rocks, contain fossils identical with those of the lower strata of the Silurian system. Perhaps these beds, as well as the grauwacke of foreign geologists, should still be included in the same system with Silurian rocks. Mr. Murchison and Professor Sedgwicke, however, think otherwise, and while the former has given positive characters to Silurian rocks, the investigations of the latter, when fully before the public, will go far, no doubt, to cast as much light upon the Cambrian system, as the nature of the beds composing it will admit of.

Experiments on the Magnetic Influence of Solar Light.

By Lieut. R. BAIRD SMITH, *Bengal Engineers.*

The repeated ebb and flow of opinion among scientific men, as to the existence of a magnetic influence in solar light, gives a curious degree of interest to the history of the question. The discovery was originally announced in 1813, by Prof. Morenchini of Rome, who asserted, that by exposing steel needles in a particular manner to the violet ray of the solar spectrum, he had succeeded in imparting to them a perceptible magnetic polarity. These experiments were repeated in the presence, and apparently to the entire satisfaction of Sir Humphrey Davy, Professor Playfair, and certain other English philosophers, who happened, at the time of their announcement, to be in Rome. The subject was altogether a curious one, and Morenchini's experiments were repeated in various quarters, and with various success. MM. Carpa and Ridolphi produced results similar to those alluded to above, but M. Berard of Montpelier, M. Hombre Firmas at Alais, and Professor Configliachi of Pavia, failed utterly in obtaining any evidence whatever of magnetic action. The balance of credit appears to have inclined in favour of the latter observers, since the discovery fell into disrepute until in 1825 it was again prominently forced on the attention of scientific men by some ingenious and apparently very decisive experiments of Mrs. Somerville. She was at the time unacquainted with the details of Morenchini's method of observing, but as it appeared to be improbable that the same cause acting upon a needle could give rise both to a northern and southern polarity, she protected one half of each of those employed by her from the influence of the sun's rays by covering it with paper, allowing the light to act on the other half. Proceeding thus, she obtained the most marked results, of which a brief detail may here be given. Having covered half of a sewing needle, about an inch long, with paper, she exposed the other half uncovered to the violet ray of a spectrum thrown by an equiangular prism of flint glass on a pannel at five feet distance. As the place of the spectrum shifted by the motion of the sun, the needle was moved so as to keep the exposed part constantly in the violet ray, and after being thus exposed for two hours, the previously unmagnetic needle exhibited decided polarity, the exposed end having the properties of a north pole. Repeated experiments were made with needles of different sizes, and placed in different positions with reference to the magnetic meridian, and with results uniformly of the same kind as the preceding. Needles were then in turn exposed to the other rays of the prismatic spectrum, and it was found, that while the indigo ray was nearly as effective as the violet, the blue and green rays only occasionally succeeded, and the yellow, orange, and red, never did so, although the same needles were exposed to their influence for several successive days. Subsequently, experiments were tried with solar light, transmitted through various coloured media, and it was found, that needles half covered with paper, and exposed under a glass coloured blue by cobalt, became after three or four hours feebly magnetic, and after six hours, sensibly and permanently so. Similar results were produced with green glass, and also with blue and green riband. Such is an outline, although no more, of the experiments of Mrs. Somerville, but I regret exceedingly, that I have been unable to procure any detailed account of the various steps in her method of observing, since although the results appear sufficiently decisive, it would have been very desirable to have had the power of remarking whether *all* sources of error had been foreseen and eliminated by her; especially as the method employed by her is one in which many such sources exist, as will afterwards be more particularly alluded to.

In repeating the experiments of Mrs. Somerville, M. Baumgartner of Vienna discovered that a steel wire, some parts of which were polished, while the rest were without lustre, became magnetic by exposure to the white or undecomposed light of the sun, a north pole appearing at each polished part, a south pole at each unpolished part, and the effect was hastened by concentrating the light upon the wire by means of a lens. In this manner eight poles were obtained on a piece of wire eight inches long.

The magnetic influence of solar light was exhibited in another form by Mr. Christie of Woolwich in 1825, he having found that the vibrations of a magnetized needle when exposed to the sun's light, ceased in a much shorter time than when it was vibrated in the shade, and this independently altogether of the effect of temperature. This effect, however, was not confined to needles that had been magnetised, since it was found to apply also to unmagnetised needles, to needles of glass and copper, vibrated by the force of torsion, with all of these it was found the arcs of vibration diminished in amplitude more rapidly in the sun's light than in the shade, in the following proportions; the terminal excess (that is, the excess of the terminal arc in the shade above that in the sun, after the same number of vibrations commencing from the same point in each case) would by the first series of experiments, be for the magnetised needle 13° 75′; for the copper needle 5° 24′; and for the glass needle 4° 71′—and by the second series of experiments, for the magnetised needle $11\frac{1}{4}°$; for the unmagnetised needle $7° \frac{5}{12}'$; for the glass needle $6° \frac{1'}{5}$; and for the copper needle 5°. "To whatever cause," Mr. Christie remarks, "we are to attribute the singular fact, that any needle will come sooner to rest when vibrated exposed to the sun than when screened, the great increase of effect which is observed when a magnetised needle is made use of, proves, I think decidedly, that the compound rays possess a very decided magnetic influence."

The experiments of Mr. Christie were repeated by Mr. Zantedeschi of Pavia, who found that by exposing the north pole of a needle, a foot in length, the semi-amplitude of the last oscillation was 6° less than the first; while on exposing the south pole, the last oscillation became actually greater than the first, a result, it must be remarked, of the most extraordinary character. This observer, however, admits, that he frequently met with the most inexplicable anomalies in his experiments; and in the abstract of them which I have seen, they are recorded in a style of peculiar vagueness and indecision.

The results now stated appear to afford a very marked confirmation to the idea of a magnetic power being resident in the solar rays, and yet a series of careful and well conducted experiments by MM. Moser and Riess have again involved the whole question in its former obscurity, they having failed completely in producing any change of magnetic intensity in steel needles exposed to the solar rays. The method of observation employed by them was to count the number of oscillations performed in a given time *before* and *after* the needle was submitted to the action of the violet rays. So decisive were their results in indicating the invariable intensity of the needles thus exposed, and also so completely did they fail in verifying the results of Baumgartner, formerly alluded to, that they consider themselves entitled to reject wholly a discovery, which for seventeen years has at different times disturbed science. "The small variations," they observe, "which are found in some of our experiments, cannot constitute a real action of the nature of that which was observed by MM. Morenchini, Baumgartner, &c. &c. &c. in so clear and decided a manner." The latest authorities, as for instance Prof. Turner, in the last edition of his Elements of Chemistry, coincide in this view of MM. Moser and Riess, so that at present the discovery of the magnetic influence of solar light is again considered more than doubtful.

Such being the present aspect of the question of solar magnetism, it ardently invites to farther enquiry; and as it appeared to me that India offered several important advantages for the investigation of such a subject, I resolved to commence a series of experiments upon it, in the hope of obtaining some interesting or decisive results. We have here the command of a solar intensity both of light and heat, far greater than observers in temperate regions can avail themselves of, while the almost uninterrupted clearness of the weather during certain seasons, enables us to prosecute our experiments from day to day with facility and certainty. At the same time it must be remarked, that advantages such as these, are far from being unalloyed, since all experiments requiring delicate apparatus and minute observation are attended in this country by peculiar difficulties—difficulties too that increase in rapidly accelerated proportions as we recede from large towns or stations. The mechanical resources necessary for the construction of scientific apparatus are peculiarly difficult to command, and in many instances, it is necessary to procure their most essential parts from great distances. Thus I have been unable to obtain a common prism from any place nearer than Calcutta, a distance of upwards of a thousand miles from the spot where these experiments have been made, and similarly with other parts of the apparatus I have employed. Still if difficulties such as these were to be allowed to deter us wholly from scientific research, but very little would be done in this country, since they meet us at every step—they may however be pleaded as a reason, why that minuteness of observation, confessedly so desirable, may not at all times distinguish our experiments, and will excuse the expedients to which we are occasionally obliged to have recourse to work out our views. Another disadvantage of localities so remote as that where the experiments to be subsequently detailed, were made, is the impossibility of obtaining books for the purposes of consultation. Of the various researches on the subject of solar magnetism to which allusion has been made, I have been able to obtain only the merest abstracts of the original memoirs, and have consequently been compelled to follow throughout my own experiments, that course which appeared to me best. The results I have obtained, I therefore give in the fullest detail, so that if any sources of error exist in them, they may readily be detected and allowed for. The experiments will be divided into the three following sections:—

Section I.—On the magnetic action of undecomposed light.

Section II.—On the magnetic action of the rays of the prismatic spectrum.

Section III.—On the magnetic action of the light, transmitted through different coloured media.

Section I.—*On the magnetic action of uudecomposed light.*

In proceeding to detail the experiments of this section, I would first describe the apparatus employed. The needles, or rather cylinders, used were of soft steel, of various lengths and diameters, as noted particularly in the subsequent tables, and having surfaces brightly polished. Each needle was fitted into a brass wire stirrup made in the following manner: a piece of very thin wire about two inches in length is bent double, a small loop is then formed by twisting the bent wire twice or thrice, leaving the ends about three-quarters of an inch long each—the wire is then placed on the centre of the needle, the right hand end seized by a piece of pincers and wrapped round the needle, and the same being done with the left hand end, the stirrup is complete. To the loop of the wire there were attached a few filaments of silk, for the purpose of suspension, the length of which, throughout the experiments, was 13 inches. The detached extremity of the suspending filament was inserted into the split made in a piece of straw, and on the needle being introduced within a large glass shade, to protect it from the wind or other disturbing causes, the straw was placed across the aperture in the top of the shade, and thus supported the needle during its oscillations. At the bottom of the glass shade was placed a graduated circle, over which the needle oscillated, and by which the oscillations were regulated.

Method of observation and adjustments.—The method of observation employed throughout this section, was to observe the time required to perform a certain number of oscillations before and after exposure to the sun's light. Since the same dynamical laws are applicable to needles oscillating under the influence of magnetic power, as to pendulums vibrating under the influence of gravitation, and since in the latter case the squares of the times of performing a given number of oscillations are inversely proportional to the force of gravity, it follows that in the former the corresponding law obtains likewise, hence then the higher the intensity of the magnetic force that acts on a vibrating needle, the more rapid will its oscillation be, and therefore by comparing the times of its oscillations under different circumstances, any variation of intensity that it may have undergone, will immediately become apparent. Accordingly, by vibrating a needle before its exposure to the sun's light, a distinct indication of its magnetic condition is obtained, while by vibrating it after its exposure, the change consequent on this exposure becomes perceptible. There cannot be a doubt of this being by far the best, and indeed I believe the only sure method of judging of changes of magnetic condition, and it is the employment of it that makes the experiments of MM. Moser and Riess so much more decisive than those of Mrs. Somerville or others, by whom a different method, to be afterwards described, was employed. During exposure, the needle was placed upon a table, and it ought to be in a direction at right angles to the magnetic meridian, since there is then the least possible chance of any interference of terrestrial magnetism with the results due to the action of solar light. This was not done by me at first, as the chance of error from the source alluded to, did not occur to me; but in the later experiments it was invariably attended to, and ought always to be borne in mind, since feeble magnetism may be imparted to a steel needle held in the direction of the magnetic meridian, especially if it approaches the line of magnetic dip, by the mere inductive action of the magnetism of the earth. While placed, therefore, in this proper position, the direct light of the sun concentrated into a focus by means of a lens 1-5th of an inch in diameter and one inch focal distance, was made to traverse one-half of the needle, invariably from right to left, a specified number of times. The exposed end, for the sake of clearness, will always be styled the *marked* end, it having been distinguished from the other by a small black dot, this other end, being the *unmarked* one. After exposure, the needle was replaced in its stirrup, and allowed to take up a fixed and settled position, so that there might be no remains of torsion in the silk filaments to interfere with the freedom of its vibrations. It was then carefully adjusted, so as to coincide with the zero line of the graduated circle, its centre being placed exactly over the centre of the circle ; a slender rod of straw introduced within the glass shade through the aperture at its top, and by means of this rod a slight impetus was communicated to the needle, by which its oscillations were established. These were allowed to diminish until the arc had a semi-amplitude of 54°, from which, as from a fixed point, the counting and registering commenced in every case. The time was registered every 60 seconds by the aid of an excellent watch, although from this not having a stop, it was a little difficult to read off with the exactness required. The results in the following table are given as they were obtained at the time of experiment, with the exception, that whereas I then endeavoured to register the amplitudes of the first and last oscillations, I found it afterwards so difficult to attend to both these and the times, that I struck out the former and attended wholly to the latter. The temperature, as being an element of some importance in experiments such as the present, is given in degrees of Fahrenheit, the needle was frequently very warm after exposure, but invariably became perfectly cold again long before the experiments with it were closed.

I now proceed to give numerical details, and adopt the tabular form, as being in every respect the most convenient and concise.

Tables of Experiments.

I.—*Experimental Needles of soft steel, and having brightly polished surfaces.*

TABLE I.

Shewing the Duration of Oscillations of Needle A. before exposure.

No. of Exp.	Date of Exp.	Hour of day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses.	Remarks.
		A. M.	P. M.							
	Jan.			In.	In.			Sca.		
1	10th	11	...	4	0·05	63°	5	76?	0	
2	...	...	...	...	...	...	5	85?	...	Needle not properly adjusted. Observation rejected.
3	...	...	...	...	...	...	5	92	...	
4	...	...	...	...	...	...	5	99	...	
5	...	...	...	...	...	...	5	96	...	
6	...	...	...	...	...	...	5	97	...	
7	...	...	...	...	...	...	5	98	...	
8	...	...	...	...	...	...	5	97	...	
9	...	...	...	...	...	...	5	98	...	
10	...	...	...	...	...	...	5	99	...	
					Sums, ...		50	861		
					Means, ...		1	19·15		

This Table being the first, exhibits considerably greater differences between the times observed than subsequent ones do, as greater facility in reading off was gradually obtained. From the circumstance previously alluded to, of the watch employed to register the times, by having no stop, single seconds may have occasionally been lost or gained during the intervals of observation; an error of this kind would, however, compensate itself in a series of observations, since the probabilities are as much in favour of its being in one direction as the other. During the day on which the above and succeeding Tables of Experiments were made, the sun was slightly clouded, so, that both its light and heat were to a certain degree interfered with.

TABLE II.

Shewing the Duration of Oscillations of Needle A. after exposure.

No. of Exp.	Date of Exp.	Hour of day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses.	Remarks.
		A. M.	P. M.							
	Jan.			In.	In.			Sca.		
1	10th	...	1	4	0·05	85°	5	99	200	
2	...	...	...	...	...	...	5	100	...	
3	...	...	...	...	...	...	5	100	...	
4	...	...	...	...	...	...	5	101	...	
5	...	...	...	...	...	...	5	101	...	
6	...	...	...	...	...	...	5	99	...	
7	...	...	...	...	...	...	5	98	...	
8	...	...	...	...	...	...	5	99	...	
9	...	...	...	...	...	...	5	100	...	
10	...	...	...	...	...	...	5	100	...	
						Sums, ...	50	997		
						Means,...	1	19·94		

TABLE III.

Shewing the Duration of Oscillations of Needle B. before exposure.

No. of Exp.	Date of Exp.	Hour of day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses.	Remarks.
		A. M.	P. M.							
	Jan.			In.	In.			Sca.		
1	12th	11	...	4	0·05	65°	20	314	0	An error in counting one vibration too many has evidently been made here. The Observation is therefore rejected. An error of this kind is very easily made.
2	...	...	...	...	...	...	20	300	...	
3	...	...	...	...	...	...	20	300	...	
4	...	...	...	...	...	...	20	300	...	
5	...	...	...	...	...	...	20	302	...	
6	...	...	...	...	...	...	20	300	...	
7	...	...	...	...	...	...	20	301	...	
8	...	...	...	...	...	...	20	300	...	
9	...	...	...	...	...	...	20	299	...	
10	...	...	...	...	...	...	20	300	...	
						Sums, ...	200	3016		
						Means, ...	1	15·011		

TABLE IV.

Shewing Duration of Oscillations of Needle B. after exposure.

No. of Exp.	Date of Exp.	Hour of day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses.	Remarks.
		A. M.	P. M.							
	Jan.			In.	In.			Sca.		
1	13th	11	...	4	0·05	85°	20	302	200	Sun very bright and powerful, sky quite cloudless.
2	...	...	...	...	...	...	20	300	...	
3	...	...	...	...	...	...	20	302	...	
4	...	...	...	...	...	...	20	302	...	
5	...	...	...	...	...	...	20	299	...	
6	...	...	...	...	...	...	20	300	...	
7	...	...	...	...	...	...	20	301	...	
8	...	...	...	...	...	...	20	300	...	
9	...	...	...	...	...	...	20	300	...	
10	...	...	...	...	...	...	20	300	...	
						Sums, ...	200	3006		
						Means, ...	1	15.03		

TABLE V.

Shewing Duration of Oscillations of Needle B. after farther exposure.

No. of Exp.	Date of Exp.	Hour of Day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses.	Remarks.
		A. M.	P. M.							
	Jan.			In.	In.			Sca.		
1	13th	...	1	4	0.05	97°	20	307	600	
2	...	...	...	...	...	...	20	304	...	
3	...	...	...	...	...	...	20	307	...	
4	...	...	...	...	...	...	20	306	...	
5	...	...	...	...	...	...	20	307	...	
6	...	...	...	...	...	...	20	306	...	
7	...	...	...	...	...	...	20	306	...	
8	...	...	...	...	...	...	20	308	...	
9	...	...	...	...	...	...	20	307	...	
10	...	...	...	...	...	...	20	307	...	
						Sums, ...	200	3065		
						Means, ...	1	15.352		

The needle *B.* was in every respect the counter-part of *A*, having been cut from the same piece of steel; the same stirrup and suspending filament were employed in both series of experiments, and the only difference between them was, that in order to ensure a greater degree of accuracy, a larger number of Oscillations was counted at each observation. The latter series were made under peculiarly favourable circumstances, the weather being still and clear, and the sun very bright and powerful, both in light and heat.

TABLE VI.

Shewing the Duration of Needle C. before exposure.

No. of Exp.	Date of Exp.	Hour of Day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses.	Remarks.
		A. M.	P. M.							
	Jan.			In.	In.			Sca.		
1	19th	11	...	5	0.04	64°	20	610	0	
2	...	...	...	...	...	...	20	614	...	
3	...	...	...	...	...	...	20	616	...	
4	...	...	...	...	...	...	20	620	...	
5	...	...	...	...	...	...	20	615	...	
Sums, ...							100	3075		
Means, ...							1	30.75		

TABLE VII.

Shewing the Duration of Oscillations of Needle C. after exposure.

No. of Exp.	Date of Exp.	Hour of Day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses,	Remarks.
		A. M.	P. M.							
	Jan.			In.	In.			Sca.		
1	19th	12	...	5	0·04	83°	20	615	200	
2	...	...	...	...	...	...	20	615	...	
3	...	...	...	...	...	...	20	615	...	
4	...	...	...	...	...	...	20	615	...	
5	...	...	...	...	...	...	20	617	...	
Sums, ...							100	3077		
Means, ...							1	30·77		

TABLE VIII.

Shewing the Duration of Oscillations of Needle C. after farther exposure.

No. of Exp.	Date of Exp.	Hour of day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses.	Remarks.
		A. M.	P. M							
	Jan.			In.	In.			Sca.		
1	19th	...	2	5	0·04	81°	20	624	600	
2	...	...	...	...	...	...	20	625	...	
3	...	...	...	...	...	...	20	624	...	
4	...	...	...	...	...	...	20	628	...	
5	...	...	...	...	...	...	20	626	...	
						Sums, ...	100	31·27		
						Means, ...	·1	31·27		

The only difference between the details of these and former experiments consisted in one-half of needle C being covered by several folds of paper, while the other half was exposed to the Traverses of the focus of concentrated light. In order that the results obtained in the present branch of our enquiry may be exhibited at one view, the following table has been prepared.

TABLE IX.

Shewing general results of Experiments on the magnetic action of undecomposed Solar Light, with needles having brightly polished surfaces.

Nos.	Dates.	Needles.	Length of Needle.	Diam. of Needle.	Duration of Oscill. before Exp.	Duration of Oscill. after 1st Exp.	Duration of Oscill. after 2nd Exp.	Remarks.
	Jan. 1842							
1	10th	A	4	0·05	19·15	19·94	......	These observations were not all made on the same day, as will be seen in the table of details for each. They are however placed in this table as if they had been so, for the purpose of clear comparison.
2	12	B	4	0·05	15·011	15·03	15.322	
3	19	C	5	0·04	30·75	30·77	31 27	

From this table, it is perfectly clear that no increase whatever of magnetic intensity had taken place in the needles A B and C, in consequence of their exposure to direct undecomposed solar light, a result in accordance with those of other observers, none of whom have ever succeeded in imparting magnetism under the circumstances described. That the differences observable in the periods of Oscillation before and after exposure are due, at least in part, to minute and unavoidable differences in the conditions of experiment for each needle, I have but little hesitation in affirming, but their extent and uniformity of direction forbid their being attributed wholly to such a cause, and warrant a remark, which I am not aware of having been previously made, namely, that brightly polished soft steel needles, after being exposed for a certain time to the direct light of the sun, and subsequently withdrawn to the shade, will vibrate in sensibly longer periods than before exposure. That this result is not magnetic in its origin, is, I think, very clearly proved by the following experiments made with the express view of testing this point. An exceedingly slender sewing needle, about one inch in length, and one hundredth of an inch in diameter, entirely devoid of all magnetism, was suspended within a glass shade by means of a single filament of silk, about six or seven inches in length, forming a very delicate and sensitive testing apparatus for magnetic polarities. To this testing needle, each of the cylinders A B and C was in turn approximated, but not the slightest indication of polar action of any kind could be obtained, the needle being utterly indifferent to the presence of the cylinders. This result, both serves to verify that given by the different method of oscillations, and to shew that to whatever cause the longer periods of oscillation after exposure are to be attributed, there is no reason to believe that magnetism is concerned in producing them. That the action of the sun is capable of producing remarkable changes in the internal constitution of bodies, while their external appearance continues unaffected, has been very strikingly established by the experiments of M. Mitscherlich of Berlin, who has found, among other instances, that prismatic crystals of the metal zinc are completely changed in form, becoming octohedrous by exposure for a few minutes to the action of the sun, and that by the same cause, prismatic crystals of nickel, without changing their external form, had become internally so altered as to exhibit when broken up, a series of octohedrons with square bases. Here, therefore, we have proofs of powerful internal molecular action consequent on exposure to the sun, and although it would be unwarrantable for me to conclude that such action had taken place in the steell needles also, the passing allusion I have made to M. Mitscherlich's results, will not be misplaced, if it shews that while no changes of magnetic condition took place in them, it is not impossible that changes of a different nature may have done so, and may have produced those dynamical differences to which reference has been made.

2nd.—Experiments with steel and iron cylinders in different degrees of Oxidation.

It being an established fact that a certain degree of oxidation pervading the mass, or distributed on the surface of steel or iron increase their susceptibility of magnetic influence, I was desirous of discovering whether the action of light could be made perceptible by using cylinders in this condition. The following experiments, were accordingly made with this view:—

TABLE X.

Shewing Duration of Oscillations of Needle D. before exposure.

No. of Exp	Date of Exp.	Hour of Day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses.	Remarks.
		A. M.	P. M.							
	Jan.			In.	In.			Sca.		
1	20th	10½	...	4	0.033	66°	10	261	0	
2	...	...	...	...	...	...	10	259	...	
3	...	...	...	...	...	...	10	258	...	
4	...	...	...	...	...	...	10	260	...	
5	...	...	...	...	...	...	10	257	...	
						Sums. ...	50	1295		
						Means. ...	1	25.91		

TABLE XI.

Shewing Duration of Oscillations of Needle D. after exposure.

No. of Exp.	Date of Exp.	Hour of Day.		Length of Needle.	Diam. of Needle.	Temp.	No. of Oscill.	Duration of Oscill.	No. of Traverses.	Remarks.
		A. M.	P. M.							
	Jan.			In.	In.			Sca.		
1	20th	11½	...	4	0.033	97°	10	262	200	
2	...	...	...	...	...	...	10	262	...	
3	...	...	...	...	...	...	10	262	...	
4	...	...	...	...	...	...	10	261	...	
5	...	...	...	...	...	...	10	261	...	
						Sums. ...	50	1308		
						Means. ...	1	26.116		

The needle D was partially oxidated on the surface, the oxidation being distributed in small patches interspersed with brightly polished spots. It is clear from the two Tables, that no magnetic effect was produced upon it by exposure, and this result was verified by means of the testing apparatus formerly described. The experiments were, however, varied in the following manner. A sewing needle 1$\frac{5}{8}$ inch long and $\frac{1}{32}$ of an inch in diameter was strongly magnetised by the aid of a horse-shoe magnet, which being placed on its centre, was made to traverse it backwards and forwards for sometime, the needle being occasionally turned round, and care being taken to pass over each portion of it an equal number of times, to insure equable distribution of its magnetism. It ought farther always to be placed in the magnetic meridian, and it may be useful to mention, that when two common bar magnets are employed instead of the horse-shoe one, to impart magnetism to a needle, their opposite poles must be placed upon its centre, and themselves being held inclined at an angle of about 23°, they must be drawn along the needle in different directions, then lifted perpendicularly, and carried well away from the needle, until they can be brought down again upon its centre, when they are again drawn along it, and so on, until it has become sufficiently magnetised. The needle above referred to, was found after magnetization, to have acquired a northern polarity at its point, and a southern polarity at its eye extremities, by which I mean, that the former pointed to the north pole, the latter to the south pole of the earth. The polarities really acquired were therefore the converse of those I have stated, but custom has sanctioned the change of terms, and that point of a needle which turns to the north, is invariably called the north pole, although southern polarity really exists in it. Some writers insist on using the rigidly correct terms, and calling the common north pole of the magnet the south pole, but this has led to much confusion, and if any change at all is adopted, the best undoubtedly would be to dispense entirely with the terms north and south, and to call the end of the needle that turns to the north pole of the earth, the marked, and the other the unmarked end, as is frequently done by the best authorities. To return, however, the magnetised needle was suspended by means of a single filament of silk within a glass cylinder open at both ends, about six inches in height, and two inches in diameter, so that the needle vibrated freely within it. This apparatus was then arranged over a slit in a table, through which slit the wires or cylinders to be tested were placed in front of the testing needle, and could be raised or depressed in any way that was necessary. When the needle became stationary in the magnetic meridian, a mark was made on the glass cylinder exactly opposite the north pole, and another mark about 45° to the east of this; from the latter mark the registered oscillations commenced; and it remained constant throughout each series of observations. The method of observation employed was first to register the duration of a certain number of vibrations of the testing needle, with the wire under experiment placed at a certain known distance in front of it, before exposure to the sun's light, and after exposure to repeat this process, the conditions of experiment continuing unaltered. The heights of the wires were measured from the surface of the table, about a quarter of an inch above which was the plane of the needle's vibration. Entire oxidation of the surface of a wire was effected by covering it with a little acid, and allowing this to act upon it for a few days, when the desired result was invariably produced.

To exhibit, if possible, the degree to which oxidation of the metal contributed to susceptibility of magnetic influence, as indicated by the testing apparatus just described, three soft steel wires of the same length, and nearly, although not quite, of the same diameter, one of which was brightly polished on the surface, another partially, and a third wholly oxidated, were placed in turn before the needle at the constant distance of three-quarters of an inch, and the duration of oscillations observed before and after exposure, with the results shewn in the annexed Table:—

TABLE XII.

Shewing Duration of Oscillations of Testing Needle, with Wires in different degrees of oxidation in front, before and after exposure.

No. of Exp.	Date of Exp.	Hour of Exp.		Length of Wires.	Diam. of Wires.	Temp.		No. of Oscill.	Dur. of Oscill. of pol. wire before Expos.	Dur. of Oscill. with pol. wire after Expos.	Dur. of Os. with partially Ox. wire before Expos.	Dur. of Oscill. with partially Ox. wire after Expos.	Dur. of Oscill. with wholly Ox. wire before Expos.	Dur. of Oscill. with wholly Ox. wire after Expos.
		A. M.	P. M.			Before Exp.	During Exp.							
1	Feb 5th.	10½	½	In. 2	Pol. W. 0.05	59°	92°	10	77	78	80	80	82	82
2	...	...	...	...	P. Ox. W 0.033	...	...	10	77	78	80	80	81	82
3	...	...	...	...	W. O. W 0.031	...	...	10	77	78	80	80	81	82
4	...	...	...	...	...	...	...	10	78	78	80	80	81	82
...	...	...	...	...	...	...	...	10	77	78	80	80	81	82
						Sums.	...	50	386	390	400	400	407	410
						Means.	...	1	7.72	7.80	8.00	8.00	8.14	8.20

From the above results it is evident, that no increase of intensity had taken place during two hours' exposure to a very powerful sun, the glare of light being on this occasion very great, and the sky perfectly cloudless. I therefore feel warranted in asserting, that the sun's light cannot communicate magnetism to steel needles having oxidated surfaces.

There is, however, a peculiar distribution of oxidation, combined with polish, which existing in steel wires, has been considered capable of insuring their magnetization by solar light, and this is when oxidated and polished portions alternate along the length of a wire. By employing wires in this state, Mr. Baumgartner found, that after exposure, they exhibited a south pole at each polished, and a north pole at each oxidated part. In attempting to verify these results, MM. Moser and Reiss failed completely, and could produce no such effects. The point, therefore, requires farther investigation, and I proceed to give the results of my experiments upon it.

The magnetic testing apparatus formerly described was employed throughout, and in the first series of experiments, the vibrations of the needle were counted, while no wire was in front, and then when the wire that had been exposed in the meanwhile, was placed before it. The wire was placed at a constant distance of one inch outside the glass cylinder.

TABLE XIII.

Shewing Duration of Oscillations of testing Needle, without and with steel wire in front, before and after exposure.

No. of Exp.	Date of Exp.	Hour of Exp.		Temp.		Diam. of Wire.	Hts. of Wire.	Ocid. or Polished.	No. of Osc.	Dur. of Osc. without Wire.	Dur. of Osc. with Wire.	Remarks.
		A. M.	P. M.	Before Exp.	After Exp.							
	Feb.					In.	In.					
1	1	12	1	63°	88°	0.05	$\frac{7}{8}$	Ox.	10	76	72	
2	...	...	...	...	...	...	$1\frac{4}{8}$	Pol.	10	75	70	
3	...	...	...	...	...	...	$2\frac{5}{8}$	Ox.	10	76	70	
4	...	...	...	...	...	...	$3\frac{2}{8}$	Pol.	10	76	71	
5	...	...	...	...	...	...	$4\frac{2}{8}$	Ox.	10	75	70	
6	...	...	...	...	...	...	$5\frac{3}{8}$	Pol.	10	76	70	
7	...	...	...	...	...	...	$6\frac{5}{8}$	Ox.	10	76	70	

A glance at the two concluding columns of this Table will shew a very decided magnetic effect due to the presence of the steel wire, to the extent of from 5 to 6 seconds of increase of intensity in the time of performing ten oscillations. Accordingly, on approximating the wire to the unmagnetic testing needle, immediate, though certainly not very strong, attraction between the two was exhibited, the needle freely following the wire through considerable arcs, and by applying the magnetic testing needle, it was found that each oxidated part had become a north, each polished part, a south pole. This distribution of the polar forces, is precisely the converse of that obtained by Baumgartner, but is conformable to some of the cases observed by Moser and Reiss. In using the magnetic needle as a means of discovering the kind of magnetism that may be resident in any part of a magnetised body, it is only necessary to bear in mind, that like poles repel, unlike poles attract each other. In the present instance it was observed, that on approaching the north pole of the testing needle to the oxidated parts of the wire immediate repulsion was manifested, indicating the presence of polarity like in kind to itself, while on approaching it to the polished parts, attraction ensued, shewing unlike, or southern polarity.

While these results indicate with perfect clearness the truly magnetic condition of the steel wire, there are certain points now to be mentioned, which make it exceedingly doubtful whether this was due to the action of solar light. The method of observation employed was, in the first place, objectionable, as it does not shew the condition of the wire previous to exposure, a point of most essential importance, since its having been left undetermined, renders it doubtful how much of the effect on the testing needle was really due to the exposure of the wire, how much to the previous state of the wire itself. It was further found that during exposure, the wire had been inadvertently placed in the magnetic meridian, and inclined in a direction approximating to that of magnetic dip, thus being in the very position of all others most favourable for being influenced by the inductive action of the magnetism of the earth, and consequently for becoming a magnet itself. This is a very essential point to be borne in mind, and in a subsequent section of this paper I shall have to point out how it has in all probability so influenced the results obtained by Mrs. Somerville and others, as to make it at least doubtful whether it has not led them astray, by being the unrecognized cause of those effects attributed by them to the action of light. The circumstances I have just alluded to, rendered it essential to repeat the experiments which appeared to favour the idea of the magnetic action of light, and the same wire was re-exposed, under proper precautions, its previous state being clearly determined by the observations in the last column of Table XIII: it was however determined anew to be certain against any intermediate changes.

TABLE XIV.

Shewing Duration of Oscillations of Testing Needle, with steel wire in front, before and after exposure of the latter.

No. of Exp.	Date of Exp.	Hours of Exp.		Temp.		Diam. of Wire.	Hts. of Wire.	Oxid. or Pol.	No. of Osc.	Dur. of Osc. before Exp.	Dur. of Osc. after Exp.	Remarks.
		A. M.	P. M.	Before Exp.	After Exp							
	Feb.					In.	In.					
1	2	10 to 11½	...	6 °	93°	0.05	7/8	Ox.	10	69	70	
2	...		...	...	...	...	1 2/8	Pol.	10	70	70	
3	...	...	...	...	...	...	2 5/8	Ox.	10	70	70	
4	...	...	...	...	...	...	3 2/8	Pol.	10	70	70	
5	...	...	...	...	...	...	4 2/8	Ox.	10	70	71	
6	...	...	...	...	...	...	5 3/8	Pol.	10	70	70	
7	...	...	...	...	...	...	6 5/8	Ox.	10	70	71	

From this Table it accordingly appears, that no increase whatever took place in the intensity of the wire after farther exposure, and it may therefore with safety be inferred, that such exposure was not originally the cause of the magnetic phenomena it displayed, but that these were due, in all probability, to the influence of the magnetism of the earth upon it. The results in Table XIII. possess considerable interest, however, because they prove clearly the susceptibility of the testing apparatus to small changes of magnetic condition, and therefore justify us in placing considerable confidence in its indications, while they farther shew how important the interference of terrestrial magnetism with such experiments may be. I do not feel competent to offer any explanation of the causes of the peculiar distribution of the magnetism throughout the wire; but that the oxidated and polished parts are invariably in opposite states, although these states are not always of the same *kind*, is a remark confirmed by all the observations that as yet have been made on the point. The following Table exhibits the results obtained with steel wires, in which the polished portions were roughly finished, and not ground smooth, as in former instances.

TABLE XV.

Shewing the Duration of Oscillations of Testing Needle, with roughly polished and oxidated steel wire in front, before and after exposure.

No. of Exp.	Date of Exp.	Hours of Exp.		Temp.		Diam. of Wire.	Hts. of Wire.	Ox. or Pol.	No. of Oscill.	Dur. of Os. before Exp.	Dur. of Os. after Exp.	Remarks.
		A. M.	P. M.	Before Exp.	After Exp.							
	Feb.					In.	In.					
1	5th	12	2	61°	79°	0·05	1	Ox.	10	63	63	
2	...	...	...	...	...	...	2	Pol.	10	71	73	
3	...	...	...	...	...	...	3	Ox.	10	81	85	
4	...	...	...	...	...	...	4	Pol.	10	96	96	

Wires prepared as the above, do not therefore give results more favourable to the theory of the magnetic action of light than we formerly obtained. There is, however, one point of difference between the last Table and those shewing the action of the wires having smooth polished surfaces, somewhat anomalous in its character; and that is, that while in the former case, increase of height of the wire produces a perceptible effect in increasing the duration of the oscillations of the testing needle, in the latter it appears to be perfectly indifferent to such increase, the times continuing the same while the heights vary from $\frac{7}{8}$th of an inch to $6\frac{5}{8}$th inches. From Table xv. it appears, that while the height of the wire varied from one to four inches, the durations of oscillation exhibited a difference between the first and fourth observation, of no less than thirty-three seconds in the time of performing ten vibrations.

Soft iron being more susceptible of magnetic influence than steel, although less capable of retaining it permanently, it appeared not unlikely that by employing it, the action of the sun's light might become apparent, while by speedily submitting it to the proper test, the acquired magnetism would not have time to dissipate itself, and would accordingly be recognised by the testing needles. Under this impression, the following experiments were made, the iron wires having each alternate inch roughly polished, the intervening one being perfectly oxidated on the surface.

TABLE XVI.

Shewing Duration of Oscillations of Testing Needle, with soft iron wire in front, before and after exposure.

No. of Exp.	Date. of Exp.	Hours of Expos.		Temp.		Diam. of Wires.	Hts. of Wires.	Ox. or Pol.	No. of Oscill.	Dur. of Oscill. before Expos.	Dur. of Oscill. after Expos.	Remarks.
		A. M	P.M.	Before Expos.	After Expos.							
						In.	In.					
1	Feb 5th.	11	1	59°	83°	0.166	1	Ox.	10	72	72	
2	..	..	..	..	..	..	2	Pol.	10	75	75	
3	..	..	..	..	..	..	3	Ox.	10	82	82	
4	..	..	..	..	..	..	4	Pol.	10	86	87	
5	..	..	..	..	..	..	5	Ox.	10	89	91	

TABLE XVII.

Shewing Duration of Oscillations of Testing Needle, with soft iron wires in front, before and after exposure.

No. of Exp.	Date of Exp.	Hours of Expos.		Temp.		Diam. of Wire.	Hts. of Wire.	Ox. or Pol.	No. of Oscill.	Dur. of Oscill. before Expos.	Dur. of Oscill. after Expos.	Remarks.
		A. M.	P. M.	Before Expos.	After Expos.							
	Feb	From.	To.			In.	In.					
1	5th.	11½	1½	59°	82°	0.031	1	Ox.	10	67	68	
2	..	..	..	..	..	—	2	Pol.	10	74	73	
3	..	..	..	..	..	—	3	Ox.	10	78	79	
4	..	..	..	..	..	—	4	Pol.	10	86	86	
5	..	..	..	..	..	—	5	Ox.	10	86	87	

Whence it appears that iron wires are not more adapted for exhibiting the magnetic action of undecomposed light than steel ones, and the general conclusion to which all the experiments detailed clearly point, is, that such action has no real existence, and that the effects attributed to it must have been due to some interfering cause capable of producing changes of magnetic condition, but unrecognised, and therefore not provided against by the observers. Having been unable to procure even the briefest statement of the details of M. Baumgartner's experiments, I cannot attempt to point out any sources of fallacy that may have vitiated their results, but of the existence of these I can entertain but little, if any, doubt, after the observations just described, which shew in the clearest manner, that when proper precaution were observed, *the magnetic condition of the steel and iron wires, under experiment, continued identically the same before and after exposure to the sun's light.*

Camp near Saharanpore,
15*th February*, 1842.

(To be continued.)

A Catalogue of the Mammalia of Assam. By H. WALKER, *Assistant Surgeon, Bengal Medical Service.*

QUADRUMANA.

1. Hylobates hooloc, Harlan. Assamese name, Hooloc.	Hooloc.
2. Semnopithecus entellus, F. Cuv.	Hoonuman.
3. Macacus Rhesus, Desm. Assamese, Lall Saunt,	Rhesus Monkey.
4. Macacus assamensis, M'Clelland,	Assam Monkey.
5. Lemur tardigradus, Linn. Assamese, Nilagi Bhundar,	Slow Lemur.

CHEIROPTERA.

6. Pteropus Edwardsii, Desm.	Edwards' Pteropus.
7. Dysopes ———,undetermined.	
8. Rhinolophus ———, undetermined.	
9. Vespertilio ———, undetermined.	

INSECTIVORA.

10. Sorex myosurus, Pallas. Assamese, Seeka,	Musk Shrew.
11. Talpa micrurus, Hodgson. Assamese, Ooloonooa.	Short-tailed Mole.

CARNIVORA.

12. Ursus labiatus, Blainv. Assamese and Bengalee, Bhalluk.	Thick-lipped Bear.
13. Ursus malayanus, Raffles,	Malay Bear.
14. Arctonyx collaris, F. Cuv. Assamese, Hunteree Borah,	Sand Hog.
15. Ailurus refulgens, F. Cuv.	Panda.

16. Mustela kathiah, Hodg. Assamese name, Durrup,	
17. Mustela flavigula, Boddaert,	Yellow-throated Martin.
18. Lutra Nair, F. Cuv. Assamese, Wood,	Otter.
19. Viverra zibetha, Linn. Assamese, Hagah Gendrah,	Zibeth Civet-cat.
20. Viverra rasse, Horsf.	Rasse Gennet.
21. Paradoxurus typus, F. Cuv. Assamese, Jymahl,	Common Paradoxure.
22. Herpestes Edwardsii, Desm. Assamese, Neool,	Edwards' Ichneumon.
23. Canis primævus, Hodg. Assamese, Kouang,	Wild Dog.
24. Canis bengalensis, Shaw,	Bengal Fox.
25. Canis aureus, Linn.	Jackal.
26. Hyæna vulgaris, Desm.	Striped Hyæna.
27. Felis tigris, Linn. Assamese, Bagh,	Tiger.
28. Felis leopardus, Linn. Temm. Assamese, Nahar Phuttické,	Leopard.
29. Felis macroscelis, Temm.	Clouded Tiger.
30. Felis viverrinus, Bennet,	Viverrine Cat.
31. Felis bengalensis, Desm.	Bengal Tiger Cat.
32. Felis chaus, Guld. Assamese, Hoppa,	Red-eared Cat.

RODENTIA.

33. Pteromys petaurista, Cuv.	Taguan Flying Squirrel.
34. Pteromys sagitta, Cuv. Assamese, Bahukek,	Arrow Flying Squirrel.
35. Scuirus bicolor, Sparam,	Javan Squirrel.
36. Scuirus hippurus, Isid. Geoff.	Red-bellied Squirrel.
37. Scuirus lokriah, Hodg.	
38. Scuirus lokroides, Hodg.	
39. Scuirus M'Clellandii, Horsf.	M'Clelland's Squirrel.

40. Gerbillus indicus, Desm. ...	Indian Gerbil.
41. Mus rattus, Linn.	Black Rat.
42. Mus decumanus, Linn. ...	Norway Rat.
43. Mus musculus, Linn. ...	Mouse.
44. Hystrix cristata, Linn. Assamese, Khetelah Pohoo, ...	Crested Porcupine.
45. Lepus ruficaudatus, Isid. Geoff. Assamese, Saha Pohoo,	Red-tailed Hare.
46. Lepus timidus, Linn. ...	Common Hare.
47. Lepus hispidus, Pearson, ...	
48. Rhizomys sumatrensis, Gray. Assamese, Samboor, ...	Sumatran Bamboo Rat.
49. Rhizomys sinensis, Gray, ...	Chinese Bamboo Rat.

EDENTATA.

50. Manis pentadactyla, Linn. Assamese, Songooee, ...	Pangolin.

PACHYDERMATA.

51. Elephas indicus, Cuv. Assamese and Bengalee, Hati, ...	Indian Elephant.
52. Sus scrofa, Linn. Assamese, Gavuree, ...	Wild Boar.
53. Rhinoceros indicus, Cuv. Assamese, Gor, ...	Indian Rhinoceros.

RUMINANTIA.

54. Moschus moschiferus, Linn. Assamese, Gan Pohoo, ...	Musk Deer.
55. Cervus Duvaucelii, Cuv. Assamese, Bhelingee Pohoo, ...	Duvaucel's Deer.
56. Cervus porcinus, Zimm. Assamese, Kojela Hern, ...	Hog Deer.
57. Cervus pumilio, Ham. Smith,	Dwarf Axis.
58. Cervus Aristotelis, Cuv. Assamese, Khat-khowah Pohoo, ...	Sambur.
59. Cervus muntjac, Gmel. Assamese, Hoogeree, ...	Muntjac.

60.	Antelope cervicapra, Pall.	Indian Antelope.
61.	Antelope ghoral, Hardw. Assamese, Deo Chagul,	Ghoral Antelope.
62.	Capra hircus, Linn. Assamese, Sagolee,	Goat.
63.	Bos taurus, Linn. var. Indicus. Assamese, Ghooroo,	Indian Ox.
64.	Bos bubalus, Linn. Assamese and Bengalee, Mahees,	Buffaloe.
65.	Bos gavæus, Smith. Assamese, Bunnooréa Ghooroo,	Gyal.
66.	Bos grunniens, Linn.	Yâk.

CETACEA.

67.	Platanista gangeteca, Roxb.	Gangetic Platanist.*

Notice of the Ursus Isabellinus, HORSFIELD.

In the 15th volume of the Transactions of the Linnæan Society, is a notice of a new species of Bear by Dr. Horsfield, founded on a mutilated skin from Nipal. Dr. Horsfield named it Ursus Isabellinus. It does not appear that any further notice of the animal has been published since Dr. Horsfield's paper, which was read to the Linnæan Society, in June 1826. The following additional particulars are derived from a living specimen now in the hands of a juggler in the neighbourhood of Calcutta. It is said to be four years old, is quite tame, and has been in the possession of its present owner three years. The man says it has not arrived at its full growth, and he has seen others

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* The above Catalogue is founded on 324 Specimens of Mammalia, collected in Assam in 1840-1. For the greater part of this collection, I am indebted to the kindness of the Civil and Military Officers in Assam, especially Major Jenkins, Agent to the Governor General; Majors Simonds and Davidson; Captains Vetch, Wemyss, Bigge, and Eld; Lieut. Reynolds; and Messrs. Bedford, Hudson, and Robinson.

upwards of three feet high at the shoulder in Cashmere, where they are numerous, and all of the same colour as the present animal. It is a female.

Measurements.	*Feet.*	*Inch.*
From the tip of the nose to the root of the tail,	4	0
Tail, including terminal hairs, ...	0	4
Head, from the tip of the nose to occiput, ...	1	0
Ditto from ditto, to internal angle of eye, ...	0	4½
Height at shoulder, ...	2	7
Ditto at haunches, ...	2	6
Length of ears, ...	0	4
Ditto ditto, with terminal hairs, ...	0	5
Circumference of the extremity of the muzzle,	0	7½
Ditto of the head at the occiput, ...	1	3½
Ditto of the trunk midway between the exterior and posterior extremities, ...	2	4

The colour is dirty yellowish white, assuming a darker shade with a slight tinge of red on the head, neck, limbs, and along the middle line of the back. A white mark is seen on the chest, of the form of a Y, the forked extremities of which pass up in front of the shoulders as high as to a point opposite the base of the ears. The hair on the upper and under-lips is also whiter than that on the rest of the body. The fur is of moderate length, being shorter than that of Ursus labiatus; but much longer than that of Ursus Malyanus. It is of a soft woolly texture, and more or less matted. The hind feet, and the anterior extremities from the thighs downwards, are covered with hair of a more bristly character. The base of the head is not surrounded with a mass of long hair as in Ursus labiatus. The claws, or the fore-feet are elongated, considerably curved, compressed, convex above, grooved beneath. The longest claw is three and a half inches in length, about three quarter inch in depth at the root, and about three lines in thickness. The claws on the hind feet are much shorter and less curved, the longest is one and a quarter inches. The head is conical, broad at the base, and quickly narrowing towards the muzzle, which is truncated. The forehead is nearly on a line with the nose, the slight elevation of the former arising in part from the character of the fur which is short, and smooth on the muzzle, and thicker and longer on the forehead. The under-lip is shorter than the upper, and is overhung by the latter, so as almost to be concealed by it when the mouth is shut. The eyes are small, and situated nearly midway between the extremity of the muzzle, and the root of the ears. Irides brown. The ears are large, rising three and a half inches above the outline of the head. There are a few short vibrissæ on the upper and under-lips. The front teeth have been extracted. There are three molars on each side above and two below, so far as can be ascertained from an imperfect view of the interior of the mouth at some paces distance. The neck is short and thick, the body robust, the limbs short and stout. The outline of the back presents a considerable eminence opposite the shoulders, behind which it is nearly horizontal, with a slight elevation opposite the haunches. There is no mane as in Ursus Syriacus. There are two pectoral, and two ventral teats. H. W.

Muscologia Intineris Assamici; or a Description of Mosses collected during the Journey of the Assam Deputation, in the years 1835 *and* 1836. *By* W. Griffith, Esq. *Assist. Surgeon, Madras Estabt.*

(Continued from page 75, vol. iii.)

Daltonia, Hook et Tayl. Musc. Britt. 138 *partim. Bridel Bryol Univ.* 2. 255.

1. *Daltonia marginata*, Griff.

Foliis oblongo-anceolatis marginibus fibrosis, seta apicem versus scabrella, capsula cum apophyse obovata inclinata.

Hab : In arboribus in Pinetis Moflong.

Museus pusillus, elegans, Caules subsimplices apice innovantes, ascendentes, vix trilineates.

Folia rafione plantæ magna siccatione tortilia, humore patentia vel ascendentia, acuminata, plicato-carinata, integerrima, marginibus fibrosis diaphanis incrassatis, vena crassiuscula infra apicem evanida donata; areolæ parvæ rotundatæ oblongæve.

F. Perichætialea pauca, subquina, minima, evenia, intergra, concava vel convoluto-coneava, exteriora lanceolato, ovata, acuminata, marginata, interiora subrotunda, brevissime apiculata, obsolete marginata.

Seta axillaris, crassiuscula, subbilinealis, rubro brunnea, apicem versus scabra et in apophysin brevem incrassata, cæterum pertotam longitudinem sublente fortiter augente minutissime scabrella.

Vaginula subcylindracea, arcta, rubro brunnea.

Paraphyses paucissimæ. Pistilla pauca longiuscule stipitata. Antheræ quas semel solum vidi pluris 5-7 ovatæ, mediocriter stipitatæ, celluloso-areolatæ, brunneæ.

Capsula cum apophyse sicca ovata, madida obovata vel obovato, pyriformis, situ fere horizontalis, æqualis, exannulata, saturate rubro-brunnea, sublente modice augente areolis oblongis quadratisve reticulata.

Membrana interna leviter adnata, subsessilis.

Peristomium exterius lutescenti-albidum, capsulam ipsam subæquans, humore demum arcte reflexile, e dentibus 16, subulato setaceis, late trabeculatis, linea longitudinale obsolete notatis, punctulato-opacis scabrellisque.

Interius e ciliis totidem alternantibus paullo brevioribus, suberectis, binatim compositis, punctulato-opacis, scabrellis, basin versus sæpe obsolete et minutissime perforatis, et imâ basi unitis in membranam brevissimam dentium peristomii exterioris basibus arcte cohærentem.

Columella inclusa, breviter apiculata. Sporula in acervulo viridia, immersa globosa lævia, diaphana.

Operculum conico-subulatum, rostro acuto recto, capsulam cum apophyse sub-æquans, brunnescenti-aureum.

Calyptra mitræformis campanulato-conica, basi (demum) fissa, pilis simplicibus longis acutis pallide stramineis hyalinis fimbriata, obsolete (madida saltem) reticulata, basi lutescens rostro sanguineo brunneo vel atrato.

Character generis in Muscol. Britt. loc. cit erroneus, præsertim quoad D. heteromallam, quæcus species neckeræ cujus peristomii interioris membrana basilaris, quamvis brevis, facile demonstratur. Dubitare igitur licet de genere Anomodon ejusdem libelli.

PLEUROPUS, GRIFF.

Seta lateralis. Per: ext: e dentibus 16. Interius e membrana alta divisa in cilia totidem alternantia irregularia, obsolete carinata. Calyptra dimidiata.

Musci arbosei repentes. Folia undique imbricata, acuminata, venatione varia. Flores monoici (an in omnibus) Capsula in species unica inæquilateralis.

Genus medium inter Neckeram et Leskiam, a priori apicem membrana basilari alta, a posteriori ciliis irregularibus obsolete carinatis distinguendum.

1. *Pleuropus densus*, Griff. t. xvii.

Folis lanceolatis acuminatissimis concavis integerrimis aveniis, capsula ovata, operculo brevirostro curvato.

Hab: In Pinetis Moflong.

Cæspilosus, luteo-nitens. Caules repentes, remossimi, ramis ascendentibus, sæpe fasciculatis, apicem versus pinnatim dispositis.

Folia siccatione adpressa, humore patentia dense imbricata, basi utrinque conspicue areolata cellulis magnis quadratis, areolis reliquis angustis. Flores monoici; masculi laterales sæpius setæ basi approximatæ, gemmiformes. Fol. perigonialia cordato-acuminata, integra, avena. Paraphyses nullæ Antheræ plures breviter stipitatæ oblongo-ovatæ apice coarctatæ (an semper) areolatæ.

F. Perichætialia ovato-oblonga, acuminatissima, recta avenea medum supra minute denticulata, bases versus laxe areolata.

Seta lateralis, rubro-sanguinea, fere uncialis, sicca tortilis flexuosaque.

Vaginula oblongo-conica, paraphysibus subexpers. Pistilla plura.

Capsula erecta, æqualis, rubro-brunnea, exannulata, exapophysata.

Peristomium exterius humore connivens; dentes 16 primo per-paria cohærentes, cito discreti, plano subulati, solidi, creberrime trabeculati, lineâ longitudinale inconspicuâ, rigidi, opaciusculi, lutescentes.

Interius e membrana breviuscula areolata, solida, sedecies plicata, dentibus peristomii. Exterioris alternantibus exeuntibus in dentes totidem plicatocarinatos, irregulares, breves, solidos, obtusos, sinubus nudi vel denticulum gerentibus.

Columella cylindraceo-clavata, apiculata, inclusa.

Sporula majuscula, lævia, fusco brunnea, immersa opaciuscula.

Operculum e basi conica, breviter curviatemque rostratum.

Calyptra dimidiata lævis, apice atrata.

2. *Pleuropus fenestratus*, Griff. t. xviii.

Foliis e basi cordato lanceolata acuminissimis planis serrulatis mediatenus 1 veniis, capsula cylindraceo-ovata, peristomii interioris membrana fenestrata pertusa, operculo longirostro.

Hab: In arboribus Mumbree et Myrung.—Cæpitosus. Caules repentes, ramosi, ramis ascendentibus simplicibus sæpuisve pluries ramosis, apicibus (saltem siccitate) incurvis. Folia undique imbricata, ascendenti-patentia, marginibus simplicibus basi subrecurvis, acumine semitorto magis serrulato, prædita vena tenui medium paullo supra evanida. Arcolæ oblongæ, angustissimæ conformes.

F. Perichætialia lanceolato-oblonga, concava, longe cuspidato-acuminata, acumine patenti recurvate denticulato, evenia vel interiora interdum obsolete 1 venia.

Seta axillaris, rubro-nitens, vix uncialis, sicca valde tortiesu. Vaginula, mediocris.

Paraphyses plures filiformes, hyalinæ interdum copiosissimæ. Pistilla plura.

Capsula erecta, æqualis, basi obsolete apophysata, annulata, rubro-brunnea.

Membrana interna distincta, sessilis.

Peristomium exterius e dentibus 16, plano-subulatis, mediocribus fragilibus, rigidis linea longitudinali inconspicua notatis, trabeculis, conventibus humore, siccitate patentissimis.

Interius e membrana areolata altiuscula, membrana speciei precedentis duplo longiore, sedicies plicata, punctulata, irregulariter-perforata, plicis exeuntibus in cilias setacea, fragillima, longitudine fere dentium p. exterioris, subcarinatis opacis, ciliolis brevibus interdum dentiformibus, persistentioribus, solitarus binisve intersectis.

Sporula globosa, lævia, immersa opaciuscula.

Columella cylindracea, apiculata, inclusa operculum e basi conicâ longe et oblique rostratum, capsulam subæquans.

Calyptra dimidiata, lævis, cum operculo decedens.

Cilia p. interioris fugacia, sunt, cave ne cum his ciliola persistentiora confundas. An separandus ob membranam p. interioris perforatam, characterem insolitum, et cilia longa magis evoluta.

3. *Pleuropus pterogonioides*, Griff. t. xx.

Foliis ovatis valde concavis acuminatis integerrimis avenies, capsula cylindracea inclinata, peristomiorum dentibus cohærentibus.

Hab: In arboribus in Pinetis Moflong.

Caspitosus, aureo-nitens. Caulis repens, vage ramosus. Rami sæpius divisi, ascendentis apicibus prasertim siccitate incurvi.

Folia undique dense imbricata, patentia valde concava acuminata in apiculum breviusculum interdum semitortum, avenia, interdum basi obsolete bistreata marginibus subrecurvis integerrimis, Areolæ angustissimæ, basilares imæ utrinque laxæ quadratæ.

F. Perichætialia exteriora lanceolata, acuminata, interiora multo majora, acuminatissima, apicibus imis scabrellis diaphanis.

Seta unciam excedens, gracilis, apice incrassata, fusco-aurea, siccatate leviter tortilis. Vaginula elongata cylindracea.

Paraphyses copiosæ, filiformes, hyalinæ. Pistilla pauca.

Capsula cylindracea, sæpius inæqualis, grisea, inconspicue areolata.

Peristomium exterius e dentibus 16, subulatis, siccitate inflexilibus, humore erectiusculis albidis obtusis crebre trabeculatis, marginibus, diaphanis conspicuis, linea longitudinati inconspicua notatis.

Interius e membrana areolata, breviuscula, tenuissima, fragillima, cellulis componentibus facillime solubilibus albida sedecies plicata, plicis exeuntibus in dentes carinatas solidos cum dentibus peristomii exterioris arcte cohærentibus subæquantibus, marginibus irregularibus, vel repandis vel grosse dentatis.

Collumella inclusa, apice truncata, valde dilatata.

Sporula.

Operculum calyptraque desiderata.

Habitus Pterogonii aurei, an affinis Neckeræ tenui Hooker Pterogonium Schwaege ?.

ANHYMENIUM, GRIFF.

Seta lateralis. Peristomium duplex, exterius e dentibus 16, (brevibus) interius e ciliis totidem alternantibus (maximis) carinato convolutis, basi angustatis; membrana basilari brevissima. Capsula subæqualis. Calyptra dimidiata.

Muscus Leskioideus, pusillus, dense cæspitosus. Flores monoici.

Anhymenium polycarpon, Griff. t. xvi.

Hab: In Buddleæ specie arboreâ ad marginem sylvæ. Mumbree copiose legi.

Caules repentes, ramosissimi, ramis ascendentibus, siccis clavato-cylindraceis, ramosis, rarius simplicibus.

Folia dense undique imbricata, siccitate adpressa, madida patentia, ovata, breviter acuminata, integerrima, percursa vena ultra medium paullo evanida, marginibus leviter recurvis, areolis subconspicuis oblongis argulatis; inferiora adpressa brunneo tincta.

Flores masculi laterates, gemmiformes, setæ basi approximati, ovati.

F. Perigonialia rotundata ovatave, avenia concava, interiora majora, Paraphyses copiosæ, longitudene variæ, filiformes vel subclavatæ, hyalinæ. Antheræ oblongæ, obliquæ, apice dehiscentes, areolatæ.

Perichætialia interiora subconformia, majora acuminibus subpatulis, vena obsoleta apicem infra evanida.

Seta lateralis e basi ramorum plerumque exserta, horum fere longitudene et subtri-linealis, apicem versus curvata, rubra.

Vaginula oblongo-cylindracea, paraphysibus hyalinis filiformibus pluribus pistilisque paucis obsita.

Capsula inclinata, subobliqua, ovatocylindracea, inconspicue areolata rufobrunnea, ore integerrimo exannulato.

Membrana interna libera.

Peristomium exterius e dentibus 16, profunde intra os thecæ exsertis, inflexilibus, brevibus, latis, plano-subulatis, obtusiusculis, crebre trabeculatis, marginatisque, linea longitudinali tenui exaratis, pallide lutescentibus.

Interius e ciliis totidem maximis dentes p. exterioris triplo excedentibus, plicato-convolutis, ideoque dorso non carinatis, acutis, basi angustatis, (ambitu ideo fusiformibus) dorso (apicibus exceptis) fissis foratisque, luteo-flavescentibus, punctulato opaciusculis, basi unitis in membranam brevissimam, lutescentem, dense areolatam, sinubus nudis.

Sporula rotundato-angulata, in acervulo viridia, immersa globosa opaciuscula.

Columella subcylindracea, apiculata inclusa.

Operculum conicum, obtusum, minute mammellatum.

Calyptra dimidiata, lævis, per totam fere longitudinem fissa.

HOOKERIA, SMITH.

1. *Hookeria Grevilleana*, Griff.

Caule decumbente simplici vel ramoso, foliis lanceolatis acuminatis acutis aveniis, capsula cylindraceo-ovata nutante, operculo e basi convexa recte subulato, calyptra integra glabra.

Hab: In ripis et rupibus madidis.

Sorureem et Mumbree.

Caulis sæpe simplex, 1½-2 uncialis ramique (si adsunt) complanati.

Folia subquad-rifariam imbricata, antica posticaque cauli subparallela, lateralia disticha paullo obliqua, integerrima, grandia longitudine bilinealia, latitudine extrema unilincalia, marginibus simplicibus, textura quam maxime cellulosa, areolis magnis fusiformi-hexagonis.

Flores monoici: masculi axillares, gemmiformes, cincti foliis perigonialibus paucis, minutis, rotundatis, aveniis, breviter acuminatis. Paraphyses paucæ breves filiformes, hyalinæ. Antheræ 2-5.

Folia perichætialia pauca, caulinis plures minora, lanceolata, acuminata, concava avenia.

Seta axillaris, basi subgeniculata, subuncialis, crassa, rubra sicca etortilis.

Vaginula brevis. Paraphyses paucæ, hyalinæ, filiformes. Pistilla pauca.

Capsula inclinata, nutans, æqualis, conspiciuscule areolata, custaneo-rubra. Membrana interna libera, stipitata.

Peristomii exterioris dentes humore inflexiles, basi connati, plano-subulati, acuminatissimi, crebre trabeculati, linea longitudinali inconspicue notati, rubri apicibus capillaceis scabrellis hyalinis.

Interioris cum membrana interna facillime solubile; cilia conniventia, plicato-carinata solida, apicibus capillaceis punctulatis scabrellisque, membrana basilaris, altiuscula pallide straminea, conspicue areolata; ciliola nulla.

Sporula minutissima, in acervulo viridia, globosa, lævia, immersa semi-diaphana.

Columella apice truncata, inclusa operculum e basi convexa longe recteque subulatum, capsula sæpius ⅓ aliquando demidio brevius.

Calyptra mitræformis, conico-subulata, celluloso-areolata.

Valde affinis H. lucenti, equâ præsertim distinguitur foliis majoribus, lanceolatis, acuminatis, semperque acutis et capsula minus ovata.

2. *Hookeria obovata,* Griff.

Caule acendembente ramoso, foliis densissime imbricatis spathulato-obovatis apice rotundalis obtusissimis ultra medium univeniis marginibus fibrosis integerrimis, floribus hermaphroditis, seta scabra, capsula horizontali oblonga-obovata, calyotra scabra, basi fimbriata.

Hab: Inveni specimen unicum fructiferum inter muscos alios e Maamloo allatos.

Caulis vage ramosus, ramique ascendentes, apicibus latiores, leviter decurvati, complanatis. Folia adpresso ascendentia, vena unica infra apicem desinente prædita, cellulis maximis sub-hexagonis areolata, marginibus integerrimis e fibris fusiformibus sub-biseriatis conflatis.

Flores hermaphroditi axillares, gemmiformes.

Folia perichætiala caulinis aliquoties minora, ovata vel lanceolata acuta vel acuminata, avenia, concava, marginibus simplicia. Paraphyses nullæ. Antheræ 2 6, fuscescentes, areolatæ, cylindraceo-oblongæ. Pistilla plura centralia.

Seta semuncialis, curvata, atro-rubra, pertotam longitudinem (apice vaginula inclusa excepta) papillis simplicibus, dentiformibus albis exasperata.

Vaginula mediocris, atro-brunnea.

Capsula æqualis, basi solida, sub lente modice augente areolis quadratis hexagonisve reticulata.

Membrana interna omnino fere libera, stipitata.

Peristomii exterioris dentes subulati, acutissimi, peristomium interius paullo excedentes incurvi, utrinque trabeculati, centro linea longitudinati lutescentiata notati, pallide lutea, apicibus punctulatis.

Interioris cilia solida, acuminatissima; membranam basilarem sedecies plicatam duplo vel paullo ultra superantia.

Sporula viridia globosa.

Columella inclusa, obovata.

Calyptra (perjunior tantum visa) mitræformis conico-subulata, papillis (setæ papillis simplicibus) exasperata, basi pilis longis simplicibus fimbriata.

Operculum desideratum.

Hujus speciei perpulchræ capsulam unam tantum vidi. Flores in exemplaribus duobus examinationi subjectis hermaphroditi, quamvis vaginula exemplaris setigeri, pistilla tantum gessit.

3. *Hookeria pulchella*, Griff.

Caule ascendente ramoso; foliis obovato lanceolatis mucronato-acutis vena ultra media marginibus fibrosis integris repandis, capsula nutanti obovato-pyriformi, calyptra integra, basi fimbriata.

Hab: In rupibus madidis sylvaticis, Surureem Mumbree et Myrung.

Caulis semuncialis, raro uncialis, interdum simplex, ramique complanati.

Folia subquadrifariam imbricata, lateralia disticha, siccitati flexuosa, marginibus recurvis; areolatio densuiscula cellulis sub 6-gonis vel rotundatis.

F. Perichætialia pauca minora, lanceolata, valde acuminata, recta.

Seta axillaris, vix semuncialis, rubra, sicca tortilis.

Vaginula brevis cylindracea, rubro-brunnea, paraphyses subnullæ, pistilla perpauca.

Capsula inclinata, nutans, vel pendula, basi solida et obsolete apophysata, obovata pyriformis vel obovata.

Membrana interna adnata.

Peristomii exterioris dentes breviusculi, acuti, crebre trabeculati, linea longitudinali conspicua, lutescentes, apicibus hyalinis.

Interioris cilia acuta, dentes peristomii exterioris longitudine paullo superantia, solida, hyalina, membrana basilari mediocri, ciliolis interjectis nullis.

Sporula minutissima, globosa, lævia, in acervulo viridia, immersa hyalina.

Columella inclusa.

Operculum conico-subulatum, rostro mediocri rectiusculo, interdum perbrevi.

Calyptra mitræformis, conico-subulata, basi fimbriata.

Variat stratura, caulibus longioribus foliis plus minus oblongis, operculo brevi-rostro, et calyptra basi, villis quasi soluta.

4. *Hookeria secunda,* Griff.

Caule decumbenti, ramis ascendentibus, foliis oblongo-lanceolatis, acutis vel breviter acuminatis argute dentatis mediatenus biveniis (lateralibus falcato-secundis, capsula cylindraeco-ovata, pendula, peristomii interioris, ciliolis nullis.

Hab: Mumbree in ripis.

Rami complanati sæpius ut videtur simplices. Folia laxiuscule subquadrifariam imbricata, antica et postica adpressa, lateratia disticha obliqua, marginibus simplicibus basin versus integris, cæterm argute dentatis prædita venis 2 sursum divergentibus medium infra vel paullo supra evanidis; areolis angustis angutatis, parietibus crassis.

Perichætialia acuminato-cuspidata, (cuspide patula denticulata) per totam vaginulam inserta, avenia, interdum obsolete bistriata.

Vaginula foliis perichætialibus nuncupata cæterum nuda.

Seta lateralis, rubra, flexuosa, unciam paullo excedens.

Capsula æqualis vel subobliqua brunnea, inconspicue areolata.

Peristomium exterius humore connivens, e dentibus 16, planosubulatis, creberrime trabeculatis, linea longitudinali semipellucida notatis, opacis, rubris apicibus albidis.

Interioris membrana breviuscula; cilia acuta, solida, punctulata, ciliola interjecta nulla.

Sporula non visa.

Operculum calyptraque desiderata.

Proxima K. falcatæ, Hook. Musc. Exot. t. 54. p. 17. a qua præsertim distinguitur foliis brevite racuminatis, capsula pendula, peristomioque interiori, quod Leskioideum.

1. *Hypnum rotulatum* Hedio. Hooker.—

—Vix. Hy.

Hab: In rupibus calcareis prope speluncam Mooosmai et in rupibus areonosis Mumbree.

Folia marginata lateralia obliqua sursum irregulariter et sæpe argute denticulata, vena ultra medium evanida accessoria lateralibus alternis tantum adjecta, æquilateralia subintegra vena excurrente prædita.

Perichætialia minora avenia concava integerrima.

Seta apice incrassata.

Capsula cylindraceo-ovata nutans aspectu cellulosa. Per. Hypni.

Cilia peristomii interioris minute perforata; ciliola interjecta irregularia.

Operculum e basi conica longe recteque subulatum capsulam excedens.

Calyptra dimidiata lævis.

Huc. referri ob verba cel. Hookeri in Musc: Exot. sub Hypno laricino, t. 35. Vix Hypopterygium rotulatum. Brid. Bryol. Univ. 2. 713.

2. *Hypnum mnioides,* Hook. Musc. Exot. p. 20. t. 77.?

Hab: In rupibus umbrosis, Churra Punjee in regione Assameia alta versus. Negrogam. Fructiferam reperi in sylva Theiferam Gubroo Purbut.

Verosimiliter species distincta ambigens inter H mnioide et spininervium, huic caule simplicii foliis angustis setaque basilari, illi foliis marginatis et carina denticulata accedens.

Habitus quo dammodo Polytrichoideus.

Color sæpius Fuscescens folia siccatione incurva, interdum obsolete tortilia.

Description of the Plates referred to in Muscologia Itineris Assamici.

Plate XVI.—Anhymenium polycarpon.

1. Plant, portion of.
2. Leaf.
3. Male flower.
4. The same leaves removed.
5. Anther.
6. Capsule.
7. Operculum.
8. Calyptra.

9. Inner membrane and peristome.
10. Tooth of the outer peristome.
11. Portion of the inner peristome and inner membrane.
12. Sporula.

Plate XVII.—Pleuropus densus.

1. Portion of the plant.
2. Cauline leaf.
3. Male flower.
4. Same leaves removed.
5. Anther.
6. Capsule with its operculum.
7. Operculum removed.
8. Calyptra.
9. Capsule.
10. Portion of capsule, outer and inner peristomes and of inner membrane.
11. Tooth of outer peristome.
12. Portion of inner peristome and membrane.
13. Sporula.

Plate XVIII.—Pleuropus fenestratus.

1. Portion of a plant.
2. Cauline leaf.
2*a*. Perichætial ditto.
3. Capsule.
4. Operculum.
5. Calyptra and operculum.
6. Inner membrane and peristome.
7. Tooth of the outer peristome.
8. Portion of inner peristome and membrane.

Plate XX.—Pleuropus pterogonioides.

1. Portion of the plant.
2. Cauline leaf.
3. Perichætial ditto.
4. Capsule.
5. Portion of capsule and outer and inner peristomes.

All more or less magnified.

Memorandum regarding Salmo Orientalis, or Bamean Trout.

By MR. GRIFFITH.

Plate I is a reduced figure from an original drawing of Salmo Oriental, the species is described p. 585 of the second volume of this work, as inhabiting the tributaries of the Oxus, on the northern declivities of Hindoo Koosh. There is no fact in Natural History so characteristic of the peculiar laws to which the distribution of species is subject, as the occurrence of Salmons on the northern declivities of the Hindoo Koosh, contrasted with the equally well established fact of their absence, not merely on the southern declivities of the same chain, but also throughout the rivers of Affganisthan and India. Considered by itself, or merely with regard to temperature, latitude, longitude, and elevation, it would be quite inexplicable; but on the other hand, when viewed in relation to the well-known habits of the Salmons, it is only what might be expected. The Salmons are known to belong to the seas of temperate climates, and to enter the mouths of rivers during spring, and penetrating to their extreme tributaries, there deposit their spawn in the gravel, beyond the reach of various injuries to which it would be subject, as well as the young fry, in less remote situations. However suitable the Himalyan and other mountain streams south of the boundary just noticed might be in point of temperature, and other circumstances adapted to the development of the young Salmon, yet the tropical seas into which these waters fall would be fatal to them, so that the absence of Salmon may be easily accounted for in all countries, the rivers of which have no communication with the seas of the temperate climates. The sea is essential to the Salmon, indeed it is their natural abode, as they leave it only for the purpose of spawning. It is evident, therefore, that the Salmon must ascend the Oxus from the sea of Aral, a distance of 1,200 miles, to the place where they were discovered by Mr. Griffith, at an elevation of 11,000 feet, nearly equal to the mean elevation of the highest chain of the Alps, from Mount Blanc to Mount Rosa.

The species although named as new, may not be so, as the Salmonidæ are extremely numerous, and consequently difficult to define; it is possible, therefore, that we may be mistaken. Lacepéde, Bloch, and Yarrell are the only authors we have been able to consult on the subject, but as specimens have been sent to England with the collections of Mr. Griffith, the question may there be decided. The figure is reduced to about two-thirds of the size of the original drawing. The form of the operculum, as represented in the figure, not corresponding with that of the specimen, we have supplied Fig 1. a correct outline of this part, Fig. 4 represents the form of the intestine in *situ.* Figs. 2 and 3, the same as removed from the fish.

Mr. Griffith remarks, that it takes the worm greedily, generally gorging the hook. In sunny days, in winter, he says it takes the fly freely, although the cold is exceedingly severe. It is found, Mr. Griffith further remarks, in the streams falling into the Bamean river, from the Kohi-Baba, as high as 11,000 feet, but a few marches nearer the plains of Toorkistan at Bajgah, Mr. Griffith learned from Captain Hay that it attains a considerable size, and that the flesh is very delicately flavoured.

Memorandum regarding the predaceous habits of certain Indian Frogs, in an instance observed by T. WRIGHT, ESQ. *at Suharunpoor.*

About the end of August 1840, Mr. Wright one evening was seated on a terrace, outside of the house, and noticed one of the large yellow ram frogs of Hindostan quietly couched under a piece of timber close to the terrace. There happened to be a quantity of chaff and grain strewed over the ground, which attracted a crowd of sparrows to the spot. The movement of the birds hopping about and pecking the grain, soon aroused the frog, which evinced its interest, by raising itself on the hind legs, and vibrating the body rapidly backwards, without breaking cover from under the timber. At length one of the sparrows came sufficiently near, when the frog in one spring of some four feet, threw itself most accurately on the bird, and seized it in an instant, taking the head, neck, and body, at once into its gape. It then sprang back to its cover, and was vigorously engaged in swallowing the bird, when Mr. Wright, who was attentively watching what was going on, pushed the frog into a corner, where he was able to seize it, and after a determined resistance compelled the reptile to disgorge its prey. The sparrow had some life remaining when drawn out.

India Review.

For a series of months past, we have been flattered by the re-appearance of articles from our pages in large editorial type in *the India Review.* Sometimes a small asterisk, and still smaller foot note indicate the source from whence they were taken, but as nothing would be easier in quoting the *India Review*, than to overlook the asterisk together with the little *ibid* to which it refers, (and which would mean nothing, unless several preceding articles, similarly appropriated, should also be quoted at the same time,) we confess it would be more satisfactory to see in full the titles of the works from which such extracts are made, inserted in italics at the end of each article. Why should an Editor be ashamed to acknowledge, freely and fully, the titles of the works from which he borrows? Where he omits to do so, or merely minces an obscure or imperfect acknowledgment, he deprives the author he quoted of his right, or evinces an unwillingness to allow it, and besides introduces an uncertainty as to authorship, which is always to be avoided. In the last number of the *Review*, there is an article on Agriculture, by Mr. Griffith, the botanist, in which the author's name is altogether omitted, and the article inserted as if it were taken from Mr. Speede's Hand-Book of Gardening, which forms the preceding subject.

We have also been accustomed to see our lithographic drawings reprinted in the *India Review,* with the title of this Journal erased from them, and that of Dr. Corbyn's substituted in its place,—a practice which surely can never be sanctioned with propriety.

CAMPHOR.

With regard to the letter of Mr. O'Reiley, which we have inserted in the correspondence, we referred to Dr. Voigt of Serampore for information relative to the plant affording the Camphor, of which specimens both of the plant itself, and of the crude Camphor afforded by it, had been forwarded by Mr. O'Reiley. Regarding the plant, Dr. Voigt states, that it belongs to De Candolle's genus *Blumia,* and is, as far as he can see, a new species; the genus however affords, Dr. Voigt remarks, several species presenting camphoraceous properties. The sample of Camphor forwarded by Mr. O'Reiley, as obtained from the plant in question, which appears to be very common on the Tenasserim Coast, we placed in the hands of the Laboratory Assistant in the Honorable Company's Dispensary, in order to have a portion of it refined, and also that the various preparations of Camphor in medical use might be prepared from it, which has been done accordingly, and the samples of the different articles obtained, have been submitted, through the proper channel, to the Medical Board.

In refining this Camphor, there is a loss of about 25 per cent. of its weight. The ordinary loss in refining China Camphor is about 19 per cent. Taking the value of the latter at 4*s.* 8*d.* per lb. in its crude state, the usual rate being for the present year 2 rupees 8 annas per lb., that of the former would be 3*s.* 9*d.*; but last year the article was obtained for 2 rupees per lb., or 11*d.* per lb. less than its cost this year, so that the Tenasserim Camphor would require to be delivered at 2*s.* 10*d.* or 1 rupee 5 annas per lb., in order to complete with the Chinese article. From the observations of Mr. O'Reiley, the plant seems to be very abundant, and the method of manufacture both simple and efficient, so that there would not appear to be any obstacle to the article becoming an important production. In its refined form, it is identical in all its properties with Chinese Camphor.

ISINGLASS.

Since the remarks on Isinglass detailed in the commencement of the present number were printed, a very important observation has been made relative to the structure of the air vessel of ***Polynemus Sélé,*** which will lead to the perfect purity of the Isinglass, and place it on a footing with the best Russian description of the article; while the abundance in which it is afforded by this fish, cannot fail to render it an object of great importance. When examining a sample of the article received from Mr. O'Reiley of Amherst, weighing 12 lbs., and which cost on the Tenasserim Coast 4 rupees, it was found that each piece, from which the outer and inner membranes are removed, consists of an outer and an inner structure. The outer structure consists of a thin lamina composed of *oblique* fibres, which are easily seen passing diagonally over the surface, and composing about ten per cent. of the whole. If the mass be divided crosswise into narrow sections, the transverse fibres may be perfectly separated into fine silky fibres, which consist entirely of pure isinglass. Mr. Scott, the Assistant, who was employed in the examination, suggested the separate analysis of the outer oblique fibres, when it was found that they consisted entirely of *fibrin,* and contained all the impurities for which the Bengal Isinglass had hitherto been considered inferior.

Comparing one of the sections from which the oblique fibres had been removed, (No. 5 in the annexed table,) with a specimen of Isinglass received from Dr. Royle, (No. 1 in the annexed table,) and said to be very pure, the resemblance was quite perfect, and it will be seen from the annexed table of analysis that, of the two, our own specimen is the purest, the "loss" being chiefly gelatine. The analysis has since been frequently repeated with invariably the same result.

Isinglass examined in the Laboratory of the H. C. Dispensary, April and May,* 1842.

Description.	Fibrin.	Albumen.	Gelatine.	Loss.	Total.
1. Good Isinglass, received as a sample from Dr. Royle, in a letter under date 29th Nov. 1841, ..	2.5	a trace.	97.5	none	100 parts.
2. Imported with Medical Stores for public use from Europe, 1840-41. Invoice price 18*s.* per lb. ..	2.5	a trace.	95.	2·5	100 parts.
3. Bengal Isinglass in the rough, as exported in 1839-40, and sold for 1*s.* 7*d.* per lb., inferior sample, ...	10.	a trace.	87.5	2·5	100 parts.
4. Bengal Isinglass in the rough, as exported 1839-40, and sold for 1*s.* 7*d.* per lb., favourable sample, ...	7.5	a trace.	90.	2·5	100 parts.
5. *Ditto with the outer oblique fibres peeled off.*	1.25	a trace.	95.	3·75	100 parts.

* The following is a note by Mr. Scott, the Laboratory Assistant, detailing the manner in which the examination was conducted:—

"Twenty grains of Isinglass was introduced into a mattrass with two ounces of distilled water, and dissolved over a water bath. The gelatinous solution being carefully decanted, was then evaporated to its proper consistence, and the weight ascertained. The insoluble portion was well washed, dried, and its weight noted. The presence of Albumen was detected by tbe solution being rendered perceptibly opaque at a boiling temperature."

Correspondence.

Extract of a Letter, from E. O'Reiley, Esq. *dated Amherst,* 6*th March,* 1842, *to* J. M'Clelland, *Assistant Surgeon, Calcutta.*

CAMPHOR.

The bottle herewith sent is part of a quantity of about120*lbs.* procured by evaporation from the tops of a plant growing most profusely throughout the jungles on this coast, (specimen in flower enclosed in the box.) The attention of a few Chinese was attracted to it some months ago, by my enquiry whether the same plant was common in China, and to what purpose it was applied. I was informed that the plant, which is an annual, was cultivated in some of the seaward provinces of China, and that the salt procured from it formed a part of their Materia Medica, being considered efficacious in cases of rheumatic pains and other diseases requiring emollients.

The whole of the apparatus employed in procuring the salt is simple in the extreme, consisting merely of a large pan into which the tops are put, with a sufficient quantity of water to cover them over, in which is placed a cylindrical casing of wood, being smallest at the top, on which is fitted a large shallow brass basin. A gradual heat is then applied, and the steam rising through the casing is condensed on the surface of the basin, which being constantly supplied with cold water, causes a crystallization of the salt; this method is so rude, that it is impossible to form any correct idea as to the proportional parts of salt in a quantity of the plants, but judging from its very strong odour when rubbed between the fingers, it may be supposed to contain a very much larger proportion than is procured by the method just stated; should it prove to be of any considerable value, or at all approaching to that placed on it by the Chinese who made it, the yearly produce of these jungles would amount to a very considerable item. On this head I shall be most happy to hear from you.

ISINGLASS.

The box contains about 12*lbs.* of this article, prepared by the method you gave sometime ago, when specimens of the fish were forwarded; this lot will enable you to form a better opinion of the article than the former specimens. I have paid 4 Rupees for the quantity now sent, to induce a greater interest being taken in it by the Burmese fishermen, and as the article obtains a footing, as being in large request, I have no doubt of being able to procure it by and bye at a considerable reduction, say at least one-third less than the price now paid.

ARROW ROOT.

The bottle now sent, I made two days ago from plants of one year old, which are the produce of a few plants presented to me by Dr. Wallich, when in Calcutta some time ago. The plant appears to thrive remarkably well here, and judging from the size of the bulbs, (one of which is now forwarded,) I should say it is not excelled by any grown in Bengal.*

Extract of a Letter from T. WILKINSON, ESQ., *Resident at Nagpore, To* J. M'CLELLAND, ESQ., *Secretary to the Coal Committee, Calcutta.*†

1.—I have the honor to acknowledge the receipt of your letter of the 25th ultimo, and in compliance with the wishes of the Committee, shall furnish you such information as I have been able to collect, regarding the ores and minerals found within the territories of the Rajah of Nagpore.

MINERALS.

2.—In Wyragurh, about 90 miles to the south-east of the city of Nagpore, there are diamond mines. I formerly visited them with Mr. Jenkins, when he was Resident at Nagpore; the following is what he has written about them: "The diamond mines of Wyragurh were formerly celebrated, though now they do not yield sufficient returns to render them worth working. The diamonds were found in earth which forms small hills in the vicinity of Wyragurh. The spots are still distinguishable where they have been dug up. During the reign of the late Raghójée Bhonsla, the mines were worked at a considerable expense, but only a very few small diamonds of little value were found, and they are now entirely neglected."

3.—At Koraree, near Nagpore, there is much white marble found, which is capable of receiving a fine polish, it is used extensively in building. A specimen is forwarded.

4.—At Seukeindan in the Larihee Hills, there is a red ochre found in large quantities, a great deal of which is exported. The natives use it in colouring their houses, and with it is dyed the clothes worn by Gissaons and Byragees, and also Tant Putties, it sells in Nagpore at 25 seers for the rupee. A specimen is forwarded.

5.—Yellow ochre is found in the Chanda district, but in what particular villages I have not ascertained. It is used for colouring houses,

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* The Arrow Root appears to be of very superior quality.—ED.

† Presented by the Committee.

by both Europeans and Natives. It sells in the city of Nagpore at 15 seers for the rupee. A specimen is forwarded.

6.—An infer description of yellow ochre is found near Kulmeshur, about sixteen miles to the east of the city of Nagpore, it is used for the same purpose as the last mentioned, and sells in the city of Nagpore at 30 seers for the rupee.

7.—There is a fossil alkali,* which the Natives call Reh, found in large quantities near Ponar, 50 miles south-west of Nagpore. It is used by the Dhotees for washing clothes, and I believe the Natives make use of it in preparing soap.

8.—Pukan red, found at Kondallee, 30 miles to the west of the city of Nagpore, the English name of it I have not been able to ascertain; it is used in medicine by the Natives, particularly for women after childbirth. I send a specimen, and shall feel obliged by your informing me what its name is in English. It sells for 28 seers the rupee.

9.—Sungjura, or Sungi Jirahal, a species of steatite or soap-stone, used by Natives in medicine; it is not found within the Rajah's country, but I believe somewhere in the Jubbulpore territory, although the exact place I have not ascertained; I will endeavour to do so. It sells in the bazar at 10 seers for a rupee. A specimen is forwarded.

10.—Tuli is found in different parts of the country, but not good. Limestone is plentiful, but good clay for making brick is scarce. There is a small hill about five miles to the west of the Residency of basaltic columns. I am not aware of the existence of coal states, fusible earth, earth oil, or any other useful minerals besides those above-mentioned. In the event of hereafter learning that such are to be found, I will inform you.

11.—Iron ore is found at many places in the Nagpore country in large quantities; the following are the names of several villages at which it is prepared; viz. Aumgaon-oomjerrie in the Suhanghurree Pergunah, Konolie in Pertaubgurh, Lahara, Bijlee, and Porara in Lanjhee, Puttrapite in Ambagurh, Agree in Chandpore, Mendkee and Ballapore in Berhampooree, Gunjumarrah in Gurh Boree, Armorie in Wyragurh, Naotulla in Nerus, and Govindpore and Shunkerpore in Chinioor. The ore is smelted in the first instance in a furnace of the shape of a pyramid made of mud, with charcoal of such wood as may be procurable, it is afterwards removed to a smaller furnace in which charcoal of bamboos or teak is used, which completes its preparation for the market. I have procured some of the ore from Aumgaon-oomerjerrie, and send a specimen.† Steel is not manufactured from any of the ores

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* A specimen is sent. It is an earth containing a small proportion of Carbonate of Soda.—Ed.

† Is sent.

of iron found in this country. At some of the places above named, a superior description of iron is prepared called by the Natives Beer, which is used for giving a finer edge to tools. I send herewith a specimen, and have sent for some of the ore from which it is made, which I will forward hereafter.

12.—Gold dust in small quantities is procurable in Jouk Nuddee, near Sonakan in Chutteesgurh, in the Mahanuddee near Rajoo in Chutteesgurh, in the Sou and Deo nuddies, in Lanjhee, and in the Marroo nuddee in the Amborah Pergunah. A caste, called Soujerries, gain a poor livelihood by collecting the sand and washing it, and then separating the gold from the finer particles of sand by means of quicksilver. I send specimens of the gold freed from the sand, and some mixed with it.

13.—If I should hereafter make any discovery of other metals or minerals, I will report the same for the information of the Committee.

Nagpore Residency, the 22d April, 1841.

The following extracts of a letter from Bagdad can hardly fail to interest our readers,* and the information given regarding a country so little known, and which so few Europeans have ever an opportunity of visiting, must be thought valuable even by the most indifferent person :—

" During my last trip up the Euphrates to Sook-el-sook and the ruins of two Babylonian cities near it, the fearful curse pronounced upon that wicked land, was impressed most deeply upon my mind. The horrible desolation; the soil full of saltpetre; the flood from the Euphrates; and the misery and oppression everywhere exercised upon the inhabitants, all speak this most strongly. The desolation has fallen not only upon Babylon, but upon all her provinces, which extend from Anna to Bussorah. Every city was built upon a high mound of mud, bricks, and straw, raised above the level of the low land around; and these mounds are the only vestige left by which we can discern where her rich cities were; for there is not a natural hill in all Mesopotamia; not a building to be seen but these mounds, which are invariably shunned by the Arab for a distance of thirty miles; not a vestige of life or dry land is to be seen, the banks of the river having been washed away, the water has flowed over the whole face of the country converting (what was formerly so fertile,) into one vast dismal sheet of bitter water, for not a rush nor a reed will grow. So, turn which way

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* We are indebted for it to Capt. Campbell of Madras, whose valuable contributions have formed so prominent a feature in our pages.—*Ed. Cal. Jour. Nat. Hist.*

you will, nothing but a painful, chilling feeling of solitude runs through the shuddering breast. The weather here (Bagdad) is bitter cold, (28th January); a sharp frost for several days having prevailed, which is an extraordinary change from the heat of summer. Here, however, a real winter is seen. Trees and shrubs all bare, the ground covered with frost, and *one day we had snow.* We had ice lying in our courtyard for two days; the sun did not melt it.

"I will now give you an account of our trip to Anna. We reached the banks of that noble river, the Euphrates, at Felugia, from thence we went to Hit, celebrated for its bitumen springs, of which there are seven, but two only are made use of, the bitumen from the rest streaming down the sides of the hills, where it congeals. This is the Hit of Scripture, and was one of the Babylonian cities destroyed. From this we reached Anna in three days, and returned by about morning, with the current at about three miles an hour. Anna is a most delightful place, the people are rosy-cheeked, active, and happy, compared with other places. The females are fair and pretty, and the whole place seemed cheerful. Fine gardens of the olive, apple, pear, and orange mingled with the date occur on the river side, watered by picturesque old ivy or moss-covered aqueducts, into which the water is raised about thirty feet by huge rudely made wheels of thirty-five feet diameter, turned slowly and groaningly by the force of the current into which the lower rim dips. A number of little pots fixed round the rim of the wheel, fill as they dip into the water, and are emptied into wooden troughs at the top. These rude, but effective machines, are found in great number all along the river to Hit, below which there being no stone or lime (to build the aqueducts or dams), the water is drawn by cattle, the same as in India. At Anna I visited a spot pointed out as where Imaum Alli, cousin of Mahomed, stamped in anger, and indented the rock with his foot. There is certainly a mark, but it required much imagination to suppose it like a foot-print. (This must be something like the cavities left in the granite rocks of South India by the decay of nests of embedded hornblende, by which every desirable locality is provided with a print of Ramaswamy's foot, or of the Bull Nundy's). At Anna also I visited with much more interest, the graves of four of the unfortunate crew of the *Tigris*, whose bodies were recovered and interred. Below Anna, we visited all the ancient Mahomedan ruins on the banks; now with all their signs of grandeur forgotten and almost unknown. To enumerate every one, would be useless. Between Anna and Hit, are Tiblis, Hadaisa, Aboose, and Jubuh, which were flourishing Christian Bishopricks in the time of the Armenian church, now all in ruins and desolation. The Arabs of the Desert being the only people met with, no man is safe who cannot carry sufficient force to intimidate those he meets, and prevent their plundering him. The wharfs, numerous corn mills, stone embankments at the bunds of the river to receive the rush of the current, the ruins of numberless aqueducts and lofty minarets, are the only signs of the past, now to be seen. Below Hit, the nature of the country alters very much from a hilly and rocky country, the stream now enters an open level country, the bank being low and formed of mould, (the alluvium of the Delta of the Euphrates here doubtless commences), and the course becomes very tortuous and winding; the rapid action of the stream on the banks causes frequent changes, by which whole towns are sometimes swept entirely away. Here the country takes an active and cheerful appearance, the natives being seen busy on the side of the river irrigating their corn fields by cattle and leather buckets, singing and responding to each other, and a stranger would little think, while he listens to their jokes and merriment, that he was passing a tribe of the greatest thieves and rascals, who for two buttons would not scruple to commit robbery and murder, and return to their buckets again with greatest *sang froid* imaginable; to us, however, they were civil enough, for they feared the strength of the party.

"Here we had an opportunity of witnessing a most pleasing sight. One evening it being quite calm, we exchanged compliments with the chief of the tribe; he expressed sincere friendship for the English, and as we left, his Moollah asked us to decide a dispute about a feast which was to commence that night or the next, but they had forgotten which. Having just come from Hit, they thought we could tell them, as they had no communication. On assuring them that the feast began that night, the Seik immediately ordered the signal to be made, on which a dozen balls of fire rose on the points of the long spears, and the men mounting galloped about, causing a most extraordinary appearance, for in a short time the country round, as far as the eye could see, appeared covered with little stars flitting about in all directions. The rest of the people commenced singing and dancing, and the watermen on the banks of the river passed rapidly the news down to each *other*, so that we found that the signal had reached Hillah the same night, a distance of 150 miles.

"From Hillah, the supposed ruins of the tower of Babel are situated seven miles distance in a S. W. direction. These remains are most admirably represented and correctly described in 'Keith on Prophecy.' The mound is now 140 feet in height, and is without question, square and solid, so that it cannot have been a palace, nor a fort, nor a storehouse, as some imagine. It is formed of bricks cemented with a kind of slime peculiar to the 'Birs,' as it is called; but what it is I could not exactly make out, but it did not seem to be bitumen. Huge masses of brick lay scattered one upon another, as from the explosion of a vast mine. Every mass, even of ten feet in diameter, is vitrified to the very centre, though the form of the bricks can still be distinctly seen, shewing the effects of a degree of heat far beyond the power of man to produce, and pointing out in the most striking manner, the effect of that Almighty power, which has effected the destruction. Having taken a hasty view of the city of Hillah, which is entirely built of the bricks from the tower of Babel, we started for the ruins of Babylon, which extend for some distance up the river. These are mounds or heaps, the first of which is called the palace of marble, from which the beautiful slabs of marble are taken and broken up for cement. Near this, the natives pointed out a large oven or furnace, partially fused like a brick kiln. This they say is the furnace into which *Daniel* was cast. It is too close to the palace to be a brick kiln, and can only have been intended for the purpose of punishment.

"A little to the north of the large hall of the palace, stands the only willow tree to be found any where in the country. It grows among the ruins, raised fifty feet at least above the level of the good soil, down to which its roots must reach, to obtain nourishment; for all these heaps of ruins are saturated with saltpetre. A little further on, is a figure of a lion standing upon a prostrate man, cut in stone, four feet high by eight feet long. Not a vestige of the city walls is to be seen, so completely have they been destroyed; but the ground for twenty miles round is strewed with bricks and pots. Not a blade of grass grows here, nor does man seek the desolate waste; save a few who live by selling bricks and antiques; beyond these heaps is a castle in which I hope to make some discoveries, but of that hereafter. To the north is the plain of Dura, where the golden image was set up."

Extract of a Letter from Dr. Boase, late Secretary to the Royal Geological Society of Cornwall. Presented by Captain Campbell of Madras.

The following may be interesting to those who have had an opportunity of perusing Dr. Boase's excellent work on Primary Geology, and I think that there are few who have studied that work, and have had opportunities of comparing his perspicuous and admirably correct descriptions with the phenomena of nature, who will not regret to learn, that the author is no longer engaged in scientific pursuits, but has been obliged to devote his time to commercial affairs. I may be allowed to record my regret on learning this, for I had looked forward to the publication of a revised and improved edition of a work, which is beyond doubt the most useful of any with which I am acquainted.

It is gratifying to learn, however, that although the opinions regarding Geological phenomena, which Dr. Boase has assumed from his own observations are totally at variance with the opinions generally received, and the current theories, and if proved by future research to be correct, will tend to overturn all existing systems, yet his labours have been well appreciated by the Geological Society, who have paid him the flattering compliment of electing him a member of their Council; a compliment the more gratifying, as it was entirely unexpected on Dr. Boase's part.

It is singular, that the information of the discoveries by Sedgwicke and Murchison should have reached us just about the time of the discoveries by Messrs. Kaye and Cunliffe at Sydrapettah, for from my knowledge of the Geology of the country lying to the west of this locality, I consider it most probable, that like the Dartmoor formation, the fossiliferous beds are superposed immediately from the granitic. Dr. Boase remarks, "You will have learnt by the reports of the Geological Society, that Sedgwicke and Murchison have traced the fossiliferous strata to the immediate vicinity of the granite of Dartmoor; they assert even to the very contact therewith, and traversed by granite veins. I should have liked to investigate this point, but had no opportunity before leaving the West of England. That the strata with organic remains may approach very near to, and even overlap the granite, is well known; and it would not be easy to trace the line of demarcation between them and the primary slates, should any here intervene, because the one being formed of the detritus of the other, and being of so old a formation, would be perfectly consolidated, and exhibit the same lines of structure. Now, if true granite veins, that is, elongations of the same mass of granite intersect the strata, and pass into or shew a similar mineral composition, then it is evident that the strata adjacent to the granite are primary according to my views, that is, contemporaneous with the granite."

Dr. Boase considers the crystalline schists and argillaceous slate not to be of sedimentary origin, but to be mechanical modifications of primary rocks, and that they are not stratified. An opinion which I consider to be corroborated by my own observation, and which I had entertained and explained to a friend at Hoonsoor, long before I met with Dr. Boase's work. "If my theory be correct, then the strata so traversed by granite veins are not fossiliferous, but will be found at some point to be distinct." Dr. Boase denies the generally received fact, of the supposed graduation of fossiliferous formations into the primary schists. If, on the other hand, it be substantiated that the very same beds with organic remains reach the granite, and at the parts adjoining are metamorphised by the action of heat, then I am in error.

Dr. Boase doubts the correctness of the assertion, that rocks are metamorphised by the action of heat when in contact with what are called "igneous rocks," and he remarks, (Primary Geology, page 306,) "Admitting these changes to have been produced by the action of in-"tensely heated trap rocks, how comes it to pass that a like cause "has not produced a corresponding effect; how is it if these rocks have "been intruded among the strata in a state of ignition, that they have "not equally altered the same rock throughout their entire course?

I have alluded in several parts of my book, more particularly in the last chapter, but more explicitly in the Annals of Philosophy, to a way in which the generally received theory and mine may be reconciled. Suppose my general views to prove erroneous, as in the above instance, then I must admit that primary crystalline schists are only secondary strata, changed by the action of heat; but in so doing I contend, that granite itself is in the same predicament; that is, that the whole of the primary rocks have then resulted by the action of fire on fossiliferous strata. It may come to this, but in the mean time, the facts are not sufficient to justify "our jumping at such a conclusion."

Upon the investigation of the points on which Dr. Boase remarks, I do not find that we have any published information as yet from the examination of the vast primary formations of South India. The only notice I am able to find, is a remark by Dr. Malcolmson, *(Journal of the Asiatic Society of Bengal,* No. 50,) where he remarks, that between Hydrabad and Nagpore at the Meeklegandy Ghaut "limestone containing shells was observed lying upon granite of a reddish colour;" but the observation is very imperfect, as it does not appear whether the rock was part of an extensive granitic formation, or only a portion of one of the granitic beds occurring in what I have termed the "schistose series;" neither does it appear, that Dr. Malcolmson endeavoured to observe, whether the fossiliferous bed was traversed by veins from the granite, or whether it was metamorphised in any way, or changed in appearance or mode of aggregation, by association with the bed of granite.

Miscellaneous.

On the Principles of Electro-Magnetical Machines, by Professor Jacobi, *of St. Petersburgh.*[*]

"I have the honour to present to the British Association an historical sketch of the laws which regulate the action of Electro-Magnetic Machines, laws which will enable us to determine in a precise manner the important question, of the application of this remarkable force as a moving power. Since the commencement of my labours, which had partly a purely practical tendency, I proposed to myself to fill up as much as possible the blank which still remained in our knowledge of electro-magnetism. With the assistance of M. Lenz, I prosecuted the labours, which were the more arduous as they had but few precedents in the direction which I considered it necessary to follow, and we began to examine carefully the laws of electro-magnets. The report, which contains the results of our researches, was read in June 1838, before the Academy of Sciences, at St. Petersburgh, I take the liberty of repeating here very briefly, the contents of this first report. The problem which we sought to determine may be stated as follows: If a nucleus of malleable iron and a voltaic battery of a certain surface is given, into what number of elements should this surface be divided? what should be the thickness of the wire of the helix which surrounds the nucleus? and, lastly, what number of turns should this helix have, in order to produce the greatest amount of magnetism? I will not dilate here upon the manner in which we have proceeded, or upon the degree of certainty which belongs to the laws established according to our observations. I take the liberty of appending to this statement the report in question, and will proceed to explain the particular laws: 1st. The amount of magnetism engendered in malleable iron by galvanic currents, is in proportion to the force of those currents. 2ndly. The thickness of the wire twisted into a helix, and surrounding a rod of iron, is absolutely of no consequence, provided that the helix have the same number of turns, and the current be of the same force. This law extends also to the case in which ribbons of copper are employed instead of wire. Nevertheless I must notice, that in order to obtain a current of equal force, it is necessary to employ a voltaic apparatus of greater force, if small wires which offer a greater resistance are

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[*] These observations are referred to, by Dr. Taylor the translator of the account of an electro-magnetic engine reprinted in our last number, vide, p. 119.

employed. 3rdly. If the current remain the same, the influence which the diameter of the helix exercises may be neglected in the majority of practical cases. 4thly. The total action of the electro-magnetic helix upon the rod of iron, is equal to the sum of the effects produced by each coil separately. Adopting these laws, and submitting them to calculation according to the formula of M. Ohm, the importance of which formula was but lately begun to be appreciated by some British philosophers, we have established the formula which contains all the particular conditions required to obtain the maximum amount of magnetism, which may be expressed in the following extremely simple manner; viz. *the maximum of magnetism is always obtained when the total resistance of the conducting wire, which forms the helix, is equal to the total resistance of the pile.* On referring to the remarkable law of the definite action of the galvanic current, established by Mr. Faraday, it is found that the magnetism of malleable iron divided by the consumption of zinc,—a quantity which we have called economic effect, is with reference to the maximum of this magnetism, a constant, or an expression into which neither the thickness of the wire nor the number of the elements into which the total given surface of the battery is divided enters, but only the total thickness of the envelope.

"Having finished these first researches, and having obtained these results, which were highly satisfactory, not only for their simplicity, but also for their practical value, we set about extending our inquiries to iron rods of different dimensions. Is there, it may be asked, any specific effect produced by the length or thickness of the nucleus? or does the degree of magnetism solely depend upon the construction of the helix, and the force of the current? The solution of this new problem presents a greater difficulty than the problem which we had succeeded in completely solving. Now, we are obliged to take iron rods of different dimensions, and, consequently, in all probability of different qualities. Similar conditions with reference to the action of the electro-magnetic helices are likewise difficult to obtain; and we soon perceived that these circumstances rendered it impossible to attain so close an accordance, as that which we had obtained in our former observations. Although these experiments were made two years ago, the results have not yet been published, because, being occupied with other labours, we have not been able to find the necessary time for their reduction and arrangement, and for the requisite calculations. Nevertheless I take the liberty of presenting to the Section some results, which are not devoid of interest, and which are intimately connected with the question of electro-magnetic machines. We submitted nine cylinders of malleable iron, each eight inches in length, and of different diameters, from three inches down to one-third of an inch, to the action of a voltaic current of the same force in each case, and we obtained the amount of magnetic force represented in the following table.:—

Diameter of the rods.	Magnetism observed.	Magnetism calculated.
3	447	442
2½	378	376
2	308	310
1½	246	244
1	175	178
$\frac{5}{6}$	158	156
$\frac{1}{3}$	142	135
½	112	113
$\frac{2}{3}$	87	91

"This calculation has been made according to the formula $m = 131.75 d + 46.75$, in which the constants have been obtained by the method of the least squares. The differences between calculation and observation, are not so large that they cannot be attributed to the inevitable errors of observation, and to circumstances inherent in the qualities of iron, &c. A similar agreement is found between other observations, which we shall describe in the report itself. I think, therefore, we may admit the following law, namely, that the *amount of magnetism received by different iron rods of the same length, and submitted to the influence of a current of the same force, is proportional to the diameter of the rods.* I must remark, that the constant which we have added in the formula depends upon the magnetic influence which the helix exercises, independently of the nucleus of iron which it incloses. The practical consequences which may be deduced from this remarkable law are of considerable importance. Among these, however, I will at present mention only the following. Having found that the amount of magnetism is proportional to the surface of the malleable iron, and taking into account the quantity of iron employed in the electro-magnets, it is ascertained that it is more advantageous to employ in the construction of electro-magnetic machines, rods of small instead of large dimensions; or rather hollow iron, in accordance with my own experiments of 1837, which are found in 'Taylor's Scientific Memoirs,' vol. ii. &c. I cannot pass over in silence the experiments of Prof. Barlow, who, as is well known, proved a long time before that the induction of the terrestrial magnetism upon malleable iron, depends only upon the surfaces, and is almost independent of the thickness. In order to ascertain the law of electro-magnets of different lengths, M. Lenz and I undertook numerous and laborious observations, which were extended even to rods of thirteen feet in length, and keeping in view at the same time the determination of the particular distribution of magnetism in the rods. Among these observations I shall only refer to such as seem most applicable to electro-magnetic machines, and which have yielded results as simple as unexpected. The following table contains the results of some observations made with rods of the same diameter, but of different lengths, covered with electro-magnetic helices, and influenced by a current of the same force. M being the magnetism of the extremities, and n the number of the coils of the helix, we have $\frac{M}{n} = x$, a formula according to which we may calculate the numbers contained in the third column. The numbers in the fourth column are deduced from a series of other observations, made with the same helix of 960 turns, which did not cover the whole length of the rods, but were collected at the extremities only, where they occupied a space of about two inches in length. The helices being the same in all the observations, it was only necessary to divide the magnetism of the extremities by 960, in order to find the numbers of this column.

Table of Experiments upon the Magnetic Forces of Rods of different lengths.

Length of the rods.	Number of Coils.	Mean Value of One Coil, if the Helix occupies the whole length.	Mean Value of One Coil, if the Helix occupies only the extremities.
3′	946	7,334	7,560
2′.5	789	6,993	7,264
2	634	7,402	6,871
1.5	474	7,880	7,491
1	315	7,847	7,573
0.5	163	7,766	7,691
		7,537	7,408

"From these numbers, it will be seen that the influence of one coil of the helix is nearly the same for all the rods, and that their length does not exercise any specific influence. It is only in proportion to the number of the turns or revolutions, and to the force of the current, that the rods can acquire a greater or less amount of magnetism. The small rods even appear to have a slight advantage over large rods, since it has been found by experiments that the actual force of rods of three feet, bears to that of rods of half a foot the ratio of seventy-three to seventy-seven. It is also found, that there is a gain of seventy-five to seventy-four when the whole length of the rods is covered, instead of simply collecting the same number of coils around the extremities. The differences between the observations and the simple laws are, as will be judged, quite inconsiderable for practical purposes, and will, in time, I hope, entirely disappear by a complete integration embracing the whole length of the rods, and founded upon the effect of an elementary part of the current. I will now hasten on to the immediate object of my present address. In March 1839, M. Lenz and I presented to the Academy of Sciences at St. Petersburgh, a report, which I shall present to the Association. It contains the result of the experiments by which we have been enabled to establish the remarkable law, *that the attraction of the electro-magnets is proportional to the square of the force of the galvanic current, to the influence of which the rods of iron are submitted.* This law is of the highest practical importance, as it serves for the basis of the whole theory of electro-magnetic machines.

" Before proceeding, I may be permitted to make some remarks concerning an instrument which I laid before the Academy of Sciences, in the commencement of this year. It is destined to regulate the galvanic current, and is of value in many investigations of this kind. During my sojourn in London, Prof. Wheatstone has shown me an instrument, founded on exactly the same principles as mine, and with very inconsiderable modifications and differences. Now, it is quite impossible that he should have had the least notice of my instrument; but as it is probable that its use may be greatly extended, I must add, that while I have only used this instrument for regulating the force of the currents, he has founded upon it a new method of measuring these currents, and of determining the different elements or constants, which enter into the analytical expressions, and on which depends the action of any galvanic combination. It is principally to the measure of the electro-motive force, by those means, that Mr. Wheatstone has directed his attention; and he has shown me, in his unpublished papers, very valuable results which he has obtained by this method.

" While these purely theoretical researches were in progress, I did not fail myself to enter directly upon the question of the practical application of electro-magnetism. Unfortunately, I cannot here give the details either of the experiments which I have made upon a very large scale, or of the machines and apparatus of various kinds which I have constructed. The necessity of multiplying the facts or tangible results—a necessity the more urgent, because the practical applications of this force increased so very rapidly—this necessity, I say, has not allowed me time or leisure to digest and arrange them. I can only here express my readiness to afford any explanation of the details which may be desired. I will, however, particularly notice the satisfactory results of the experiments made last year with a boat of twenty-eight feet in length and seven and a half feet in width, drawing $2\frac{3}{4}$ feet of water, and carrying fourteen individuals, which was propelled upon the Neva at the rate of about three English miles in the hour. The machine, which occupied very little space, was set in motion by a battery of sixty-four pairs of platina plates, each having thirty-six square inches of surface, and charged, according, to the plan of Mr. Grove, with nitric and diluted sulphuric acid. Although these results may perhaps not satisfy the exaggerated expectations of some persons, it is to be remembered, that in the first year, namely, in 1838, this boat being put in motion by the same machine, and employing 320 pairs of plates, each of thirty-six square inches, and charged with sulphate of copper, only half this velocity was obtained. This enormous battery occupied considerable space, and the manipulation and the management of it was very troublesome. The judicious changes made in the distribution of the rods, in the construction of the commutator, and lastly, in the principles of the voltaic battery, have led to the successful result of the following year, 1839. We have gone thus on the Neva more than once, and during the whole day, partly with and partly against the stream, with a party of twelve or fourteen persons, and with a velocity not much less than that of the first invented steam-boat. I believe that more cannot be expected from a mechanical force, whose existence has only been known since 1834, when I made the first experiment at Königsberg, in Prussia, and only succeeded in lifting a weight of about twenty ounces, by even this electro-magnetic power.

"I must, on the present occasion, confess frankly and without reserve, that hitherto the construction of electro-magnetic machines has been regulated in a great measure by mere trials; that even the machines constructed according to the indisputable laws established with regard to the statical effects of electro-magnets, have been found inefficient, as soon as we came to deal with motion. Being always accustomed to proceed in a legitimate manner, and feeling great regret at the irregular attempts which were being made every-where, without any scientific foundation, this state of things appeared to me so unsatisfactory, that I could not but direct all my efforts to ascertain clearly the laws of these remarkable machines. I submit the formulæ relative to these laws, which appear to me to recommend themselves as much by their simplicity as by the natural manner in which they develope themselves. Let R. represent all the mechanical resistances acting upon the machine, and v, the uniform velocity with which it moves: we have for the power or mechanical effect, the expression $T = R\ v$. Let n be the number of the coils of the helix which covers the rods; z, the number of the plates of the battery; B, the total resistance of the galvanic circuit; E, the electro-motive force; k, a co-efficient, which depends on the arrangement of the bars, the distance of the poles, and the quality of the iron; we have then for the maximum of the mechanical effect which will be obtained, the expression—

$$\text{I.} \qquad \underset{m}{T} = \frac{z^2\ E^2.}{4\ Bk}$$

For the velocity, which corresponds to this maximum,

$$\text{II.} \qquad v = \frac{B\ .}{kn^2}$$

For the resistance acting upon the machine,

$$\text{III.} \quad R = \frac{n^2\ z^2\ E^2.}{4\ B^2}$$

Lastly, for the economic effect, *i. e.* the duty or the mechanical effect divided by the consumption of zinc in a given time,---

$$\text{IV.} \qquad O = \frac{E\ .}{2\ k}$$

" These formulæ may be expressed in the terms :—

" 1st. The maximum of mechanical effect which may be obtained from a machine, is proportional to the square of the number of voltaic elements, multiplied by the square of the electro-motive force, and divided by the total resistance of the voltaic circuit. There enters, moreover, into the formula, a factor, which I have designated k, and which depends upon the quality of the iron, the form and disposition of the rods, and the distance between their extremities. The result is, that with reference to some other investigations, which I have made of voltaic combinations, and under similar conditions, the use of platinum, zinc, the resistance being the same, will produce an effect two or three times greater than the use of copper, zinc.

" 2nd. Neither the number of the coils of the helix which covers the rods, nor the diameter or the length of the rods themselves, has any influence upon the maximum of the power. It results, therefore, that neither by adding to the length or diameter of the rods, nor by employing a greater quantity of wire, can the power be increased. There is, however, this remarkable fact, that the number of coils disappears from the formula, simply because the force of the machine is in a direct ratio, and the velocity is in an inverse ratio, to the square of this number. It is thus that the number of coils, the dimensions of the rods, and the other constituent parts of an electro-magnetic machine, should be considered simply as occupying the range of the ordinary mechanisms which serve for the transmission or transformation of the velocity, without increasing the available power. So it would be possible to use, instead of the ordinary wheelwork, rods of greater or less length, or a greater or less quantity of wire, in order to establish between the force and the velocity, the relation which the applications to manufacturing processes may require.

"3rd. The mean attraction of the magnetic rods, or the pressure which the machine can exert, is proportional to the square of the current. This pressure is indicated by the galvanometer, which in this manner performs this function of the manometer of steam-engines.

"4th. The economic effect, *i. e.* the duty or the available power, divided by the consumption of zinc, is a constant quantity, which is exposed most simply by the relation between the electro-motive force and the factor *k*, which has been previously noticed. I may here repeat, what I stated elsewhere, that by employing platinum instead of copper, the theoretical expenses may be reduced in the proportion of nearly 23 to 14.

"5th. The consumption of zinc, which takes place while the machine is at rest, and does no work at all, is double that which takes place, while it is producing the maximum of power.

"I consider that there will not be much difficulty in determining with sufficient precision the duty of one pound of zinc, by its transformation into the sulphate, in the same manner that in the steam-engine, the duty of one bushel of coal serves as a measure to estimate the effect of different combinations. The future use and application of electro-magnetic machines appears to me quite certain, especially as the mere trials and vague ideas which have hitherto prevailed in the construction of these machines, have now at length yielded to the precise and definite laws which are conformable to the general laws which nature is accustomed to observe with strictness, whenever the question of effects and their causes arises. In viewing on the one hand a chemical effect, and on the other a mechanical effect, the intermediate term scarcely present itself at first. In the present case, it is magneto-electricity, the admirable discovery of Faraday, which we should consider as the regulating power, or, as it may be styled, the logic of electro-magnetic machines."

Prof. Forbes congratulated the Section on the advance made towards introducing electro-magnetism among our useful moving powers. Here was a boat, twenty feet long, capable of containing fourteen people, propelled by it on the Neva, at the rate of three miles an hour: a more successful result than had for many years been attained in the use of steam for a similar purpose.—A gentleman asked the power of the engine.—Prof. Jacobi replied, about 1 or 1.5 horse, but the term horse power was itself vague.--*Reports British Association of Athemeum No.* 678 *October*, 1840.

Third Meeting of the Men of Science of Italy.

The men of science of Italy have selected Florence as the place of their third meeting as well from its being the place which, after having given birth to the revival of literature and the arts, was the cradle of experimental philosophy, as from its being the royal seat where was first entertained the thought of this new and great institution, and in which a high-minded prince has raised to the divine Galileo a temple wherein his manuscripts and apparatus will be preserved as a large part of the glorious inheritance of Italy.

It occurred to every one that the friends of science assembled in Florence, in the midst of such numerous splendid monuments of art and science of past and present times, would feel incited by these recollections to pursue the course gloriously opened by our forefathers, and by so doing would pay the deserved tribute of their gratitude to the prince who encouraged the progress of the science, and promoted the honour of his country.

It is satisfactory to announce, that the Grand Duke, our sovereign, approving the selection of his capital for the place of the third meeting of the Italian Savans, and having promised to aid its objects in every manner with his royal bounty and patronage, permits that the meeting should commence the 15th of September, 1841, to continue to the end of that month.

The regulations determined on at the first meeting in Pisa have conferred the right of taking part in the scientific meeting on the Italians belonging to the principal academies or scientific societies for the advancement of natural knowledge; the professors of the physical and mathematical sciences; the directors of the higher branches of study, or of the scientific establishments of the various states of Italy; and the chief officers of the corps of engineers and artillery. Foreigners coming under any of the above descriptions will be also admitted to the meeting.

We feel sure that our brethren who enjoy the privilege of attending the meeting will gladly avail themselves of it, and thus contribute to the great advantages which it confers upon the whole body of speculative and practical sciences. It is hoped that the invitation to scientific foreigners will prove not less effectual, as the estimation in which they hold Italian science is a pledge that they will be anxious to witness all that Italy has done and is doing, and to afford their co-operation in the noble undertaking.

A future advertisement will announce the final and special arrangements for the meeting and for the accommodation of those who may attend it. In the mean time, it is satisfactory to state that there have been elected to the office of Assessors, Prof. Gaetano Georgini, Superintendent of the Studies of the Grand Duchy, and Cav. Giuseppe Gazzeri, Prof. in the University of Pisa.—*Ann. and Mag. of Nat. Hist.*

Florence, Dec. 28, 1840.

The President General,	The Secretary General,
Marchese Cosimo Ridolfi.	Cav. Ferdinando Tarturi.

Dr. Lush on the Madi, or Chili Oil-seed, Madia sativa.

"We insert a paper by Dr. Lush, of the Medical Establishment of this Presidency, which brings to notice a new seed, called the 'Madi, or Chili Oil-seed,' which promises to be a valuable adjunct to the plants of that class in this country. It appears to flourish in a high and dry land, and will probably succeed in the Deccan and Southern Mahratta country. Dr. Lush has presented it to the Agricultural and Horticultural Society in Bombay, by whom it will be tested, and its uses fully developed.

"The demand which now exists for oil-seeds from British India has caused much attention to be drawn towards such products as may be raised in sufficient quantities, and at such a price, as may ensure them a permanent place among Indian exports to England. On the western side, or the districts under Bombay, we find, that for field produce as oil-seeds we must look out for such articles of cultivation as will not require irrigation, seeing that the sesamum, the kerday, the linseed, and the castor-oil are all produced in different districts of our Presidency as dry crops. Besides those already mentioned, we find a quickly-growing plant in the Deccan, sown usually with the ordinary crops of bajree and pulse; viz. the *Verbesina sativa* (since called *Guizotia oleifera*), or Black Til. This plant is valuable to the natives from its quick and hardy growth in a dry climate and scanty monsoon; but from the small quantity of oil in proportion to the bulk, and the inferior quality of that oil, it is not a plant likely to attract attention beyond local wants.

"The Madi (*Madia sativa*) is a plant of the same habit, and allied in botanical characters to the *Verbesina*. It has lately been grown in England by one or two experimentalists, in the hope of obtaining an indigenous oil of a superior quality. Professor Lindley, who has grown a portion at the Horticultural Society's Garden at Chiswick, is of opinion that the climate of England is too damp and cold for the Madi; and on my requesting to be furnished with seed for trial in the dry parts of India, he kindly sent me a liberal supply (which I have brought here overland), and agrees with me in the opinion that it will stand a good chance in the high and dry lands of the Deccan and other similar districts of India. A plant requiring no more care in the cultivation than the black til of the Deccan, and producing an oil second only to that of the almond and olive, and superior to the sesamum, (the common 'sweet oil' of Western India), must prove a valuable addition to the produce of the country, and as such I commit it to the care of the Agricultural and Horticultural Society of Bombay without further recommendation, merely subjoining a notice of what has already been mentioned by authors about this hitherto neglected plant.

"DeCandolle, in his 'Prodromus,' gives a full description of the plant, and notices shortly that the seed is used for making an oil. This oil, however, does not seem to have attracted the notice of commercial persons, and the only account of it I could procure in London was kindly pointed out to me by my friend Professor Don, in a work published in the year 1711, (in the library of the Linnæan Society of London), 'Histoire des Plantes Médicinales de Perou et de Chili,' by Mons. Feuillée. Of this account the follwing is a translation:—

"'An admirable oil is made from the seeds of this plant throughout all Chili. The natives make use of it not only as a local application to assuage pain, anointing with it the parts affected, but also as a condiment, and besides for burning in lamps. I found it,' says M. Feuillée, 'sweeter and of a more agreeable taste than the greater part of our olive oils; its colour is the same. There are no olives in Chili, and whatever olive oil is found there is brought from Peru, where a large quantity is made.'

"I beg to present the Society with an original coloured drawing of this plant, made for me in August last at Chiswick, by Mr. Hart, lately draughtsman to the Botanical Register.—Charles Lush, M.D."
—*Bombay Gazette, 26th November*, 1840.

Meteorological Register kept at the Surveyor General's Office, Calcutta, for the Month of March 1842.

The Observations after Sunset are made at the Hon'ble Company's Dispensary.

March. Days of the Month.	Moon's Changes.	Observed at 9 H. 50 M.					Observed at 4 P. M.					Rain Gauges.		Observations made at 8 P. M.				Observations made at 10 P. M.			
			Temperature.			Wind.		Temperature.			Wind.				Temperature.				Temperature.		
		Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.
		Inches	°	°	°		Inches	°	°	°		Inches	Inches	Inches	°	°	°	Inches	°	°	°
1		29,810	79,7	81,8	72,0	N. W. ..	29,749	84,9	97,8	82,2	W.			30,00	81,0	81,0	79,75	30,00	81,0	80,75	79,0
2		,902	80,2	84,1	75,0	E.	,770	84,1	93,0	77,0	N. E. ..			29,95	81,0	82,0	80,75	29,95	81,0	82,0	80,5
3		,878	80,8	84,2	77,0	S. W. ..	,753	87,4	92,1	73,0	W.			,90	81,5	82,0	81,0	,90	82,0	82,0	81,0
4	☾	,897	76,2	78,2	77,0	S.	,794	82,1	91,1	82,2	N.			,90	82,0	82,75	91,0	,90	82.0	82,0	80,75
5		,826	79,5	82,0	78,4	S.	,730	85,6	89,8	84,0	S.			,95	82,0	81,0	79,5	,95	82,0	81,0	79,5
6		,754	82,0	85,0	81,0	S.	,686	87,2	92,0	85,0	S. S. W.			,85	84,0	84,0	82,5	,85	83,0	81,0	79,0
7		,790	82,0	85,3	82,0	S.	,710	88,0	92,2	85,5	S.			,85	84,0	83,5	82,0	,85	84,0	82,0	80,75
8		,770	81,2	84,0	79,8	S.	,705	85,6	92,8	87,5	S.			,85	84,0	82,0	81,0	,85	84,0	82,0	81,0
9		,825	80,7	81,5	79,4	S. E. ..	,730	81,1	80,2	77,0	S. E. ..			,90	83,0	82,0	80,75	,90	83,0	82,0	80,75
10		,858	80,8	83,0	78,1	S. S W.	,769	85,6	92,1	86,0	S.			,90	83,5	83,0	82,0	,90	83,5	83,0	81,75
11		,862	79,9	82,0	79,0	N. W. ..	,738	82,0	84,6	81,0	N. E. ..			,85	84,0	83,0	81,5	,85	84,0	83,0	81,5
12	●	,762	81,8	84,0	79,1	S. S. W.	,698	85,8	89,0	84,2	S.			,85	84,0	82,0	80,75	,85	84,0	82,0	80,75
13		,729	81,8	85,1	81,7	(High) S.	,631	87,1	91,0	85,4	S.			,75	83,0	81,0	80,0	,75	83,0	81,0	80,0
14		,642	83,0	86,2	81,3	S. S. W.	,574	88,0	91,8	85,9	(High) S.			,75	85,0	84,0	83,0	,75	85,0	83,0	82,0
15		,705	81,0	86,0	77,2	N. W. ..	,654	84,5	94,0	83,8	W. S. W.			,80	85,0	84,0	82,5	,80	85,0	83,0	81,75
16		,702	80,0	82,8	78,5	N.	,641	84,3	91,0	82,2	N.			,85	84,0	84,0	82,75	,85	84,0	84,0	82,5
17		,790	78,9	76,9	75,3	N. E. ..	,738	83,0	89,8	82,8	E.			,85	83,0	83,0	82,0	,85	83,0	83,0	82,0
18		,889	80,7	85,3	77,0	N.	,809	83,8	82,7	81,8	N. W. ..			,90	83,0	83,0	81,75	,90	83,0	83,0	81,77
19		,930	80,0	84,0	78,1	S. W. ..	,838	83,8	95,0	86,2	N. W. ..			,90	83,0	82,0	80,75	,90	83,0	81,75	80,75
20	☽	,961	81,0	84,0	79,1	S.	,746	85,5	89,0	80,1	S.			,95	80,0	79,5	78,0	,95	80,0	79,0	77,75
21		,821	72,4	68,0	66,8	E.	,749	77,5	79,0	75,0	S. W. ..		3,37	,95	81,0	79,75	78,0	,95	81,0	79,0	78,0
22		,905	73,8	76,5	73,0	N. W. ..	,853	78,5	82,7	78,9	N. W. ..			,95	81,0	80,0	78,75	,95	81,0	80,0	78,75
23		,925	77,1	82,5	77,8	N. E. ..	,841	80,6	88,4	82,9	N.			,95	80,0	81,0	79,5	,95	80,0	81,0	79,5
24		,862	78,2	83,8	79,0	W.	,761	82,0	86,4	81,7	S.			,95	80,0	80,0	79,0	,95	80,0	80,0	79,0
25		,810	77,8	81,9	78,6	E.	,738	83,0	88,0	82,9	S. W. ..	0,35	0,39	,95	81,0	81,5	80,75	,95	81,0	81,0	80,75
26	○	,869	76,4	80,3	75,8	W.	,766	79,4	90,0	82,6	S. W. ..			,95	82,0	81,0	79,75	,95	82,0	81,0	79,75
27		,841	78,5	85,0	79,8	W.	,770	84,8	92,3	83,0	W. S. W.			,95	82,0	81,5	80,0	,95	82,0	81,5	80,0
28		,874	79,8	84,0	80,5	S.	,817	83,8	92,7	81,3	W.			,95	82,0	81,0	80,0	,95	82,0	81,0	80,0
29		,874	81,1	85,0	81,0	S. W. ..	,802	86,5	92,3	80,0	S.			,95	84,0	82,0	80,75	30,00	84,0	82,0	80,75
30		,834	82.0	86,4	80,8	S.	,737	85,4	87,5	80,6	S. W. ..			30,00	84,0	82,0	81,0	29,95	84,0	82,0	81,0
31		,778	82,5	85,7	81,1	S. W. ..	,700	87,0	96,6	86,0	S. W. ..			29,95	85,0	84,0	82,75	,95	85,0	83,0	82,0
Mean.		29,825	79,7	82,7	78,1		29,742	84,1	90,2	82,1		0	3,76								

N. B. From a comparison of the two Barometers, the Mercury in that at the Dispensary stands 1-10th of an inch higher than that in use at the Surveyor General's Office.

Meteorological Register kept at the Surveyor General's Office, Calcutta, for the Month of April 1842.

The Observations after Sunset are made at the Hon'ble Company's Dispensary.

April. Days of the Month.	Moon's Changes.	Observed at 9 H. 50 M.					Observed at 4 P. M.					Rain Gauges.		Observations made at 8 P. M.				Observations made at 10 P. M.			
			Temperature.			Wind.		Temperature.			Wind.				Temperature.				Temperature.		
		Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Directions.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.
		Inches	°	°	°		Inches	°	°	°		Inches	Inches	Inches	°	°	°	Inches	°	°	°
1		29,734	83,5	88,0	83,9	W. S. W.	29,610	88,7	99,2	85,0	W.			29,80	85,5	85,0	83,0	29,80	86,0	84,25	84,0
2		,682	84,3	87,9	84,0	S. W.	,589	90,1	98,4	88,2	S.			,85	86,0	85,0	83,0	,85	86,0	85,0	83,0
3	☾	,646	85,7	89,8	84,0	S. W.	,562	92,4	96,2	92,0	S.			,85	86,0	84,0	82,5	,85	86,0	84,0	83,0
4		,674	85,0	89,8	84,6	S. W.	,626	94,4	99,1	88,8	S.			,80	85,5	83,0	83,0	,90	86,0	84,0	83,5
5		,746	85,5	92,0	88,0	S.	,662	90,1	102,7	89,7	W.			,75	84,5	84,0	82,75	,80	85,0	84,0	83,0
6		,757	85,5	92,7	82,7	S. W.	,658	92,0	101,8	88,0	S. W. ...			,75	84,75	84,0	83,0	,75	84,75	84,0	83,5
7		,745	87,0	93,8	84,2	S. W.	,642	94,8	101,8	84,0	S.			,85	85,0	84,0	83,5	,85	85,0	84,0	83,5
8		,702	85,8	90,2	86,0	S. W.	,590	91,8	102,0	87,2	S. W.			,85	86,0	85,5	83,0	,85	86,0	84,5	83,0
9		,730	85,9	92,0	85,0	S. W.	,654	90,5	100,0	87,0	W. S. W.			,95	86,0	86,0	82,5	,90	86,0	85,5	82,5
10		,762	86,0	89,0	84,0	S. W.	,693	91,2	94,0	87,0	S. W.			30,00	86,5	85,75	83,0	30,00	86,0	85,0	85,0
11	●	,786	86,4	89,0	84,0	Sw. (high)	,713	89,5	92,0	86,2	S. (high)			,00	87,0	86,0	83,0	,00	86,5	86,0	83,0
12		,790	86,1	89,2	83,0	S. (high)	,698	89,3	92,0	84,8	S. (high)			,00	87,75	86,0	83,0	29,75	87,0	86,0	83,0
13		,778	86,0	90,3	85,0	S. W.	,694	92,3	98,0	89,0	S. W.			29,75	84,5	84,5	80,0	,75	84,5	84,5	83,0
14		,770	86,2	94,5	84,0	W.	,686	91,3	101,0	89,0	S. W.			,80	85,5	85,0	82,0	,80	85,5	85,0	82,5
15		,785	86,0	93,5	85,0	W.	,702	92,0	101,0	85,0	S. W.			,80	85,0	85,0	82,0	,80	85,0	85,0	82,0
16		,750	87,0	92,5	85,5	S. W.	,653	92,2	102,8	84,0	S. W. ...			,80	85,0	84,75	83,0	,80	85,0	84,75	83,0
17		,745	87,0	92,0	86,0	S.	,661	92,8	95,5	86,4	S. (high)			,85	86,0	85,0	82,0	,85	86,0	85,0	82,0
18	☽	,722	87,4	90,0	84,0	S. (high)	,662	93,2	99,0	88,2	S.			,85	86,5	86,0	82,0	,85	86,5	86,0	83,0
19		,710	88,0	91,0	85,0	S. (high)	,614	91,3	94,2	87,0	Sw. (high)			,95	86,5	86,0	82,5	,90	84,0	84,0	83,75
20		,738	87,2	89,5	84,0	S.	,670	90,5	93,0	86,0	S.			30,00	86,75	86,0	83,5	30,00	86,75	86,0	83,75
21		,689	87,8	90,2	82,5	Sw. (high)	,557	89,5	92,0	86,0	S. (high)	1,16	1,26	,00	87,0	86,0	83,5	,00	87,0	86,0	83,0
22		,698	80,0	74,9	74,0	S. E.	,610	80,0	77,6	76,0	N. W. ..	0,79	1,08	29,80	84,5	86,0	83,0	29,80	84,5	86,0	83,0
23		,710	85,8	88,3	84,0	S.	,654	88,2	89,4	86,0	S. W.			,85	85,0	85,0	83,0	,85	85,0	85,0	83,0
24		,790	85,5	89,1	85,0	S. W.	,685	87,2	90,2	84,6	S.			,85	86,0	86,0	83,0	,85	86,0	86,0	83,0
25	○	,790	86,2	88.0	84,9	S. (high)	,709	87,1	88,0	84,0	S.			,90	86,5	86,0	83,5	,90	86,5	86,0	83,5
26		,790	86,0	90,5	85,6	S.	,725	89,8	94,0	86,0	S. W.			,95	87,0	86,5	82,0	,95	87,0	86,5	83,5
27		,815	86,2	89,2	84,0	S. W.	,734	90.0	93,8	87,3	S.			,95	87,75	86,75	84,0	,95	87,75	86,75	84,0
28		,770	86,5	89,2	84,0	S.	,630	90,2	93,5	86,0	S.	0,19	9,25	,90	83,0	81,0	80,0	,90	83,0	82,0	80,0
29		,698	85,2	86,1	84,0	S.	,597	88,0	89,5	85 8	S.	0,51	0,68	,90	82,5	81,0	80,0	,90	83,0	82,0	80,0
30		,794	81,0	82,2	78,8	S.	,709	86,2	89,4	80,0	S. (high)	0,41	0,46	,95	82,5	81,0	80,0	,90	82,5	81,0	80,0
31																					
Mean.		29,743	85,7	89,5	84,0		29,655	90,2	95,4	86,1		3,06	3,78								

N. B. From a comparison of the two Barometers, the Mercury in that at the Dispensary stands 1-10th of an inch higher than that in use at the Surveyor General's Office.

Meteorological Register kept at the Sur [illegible] *Company's Dispensary.*

Calcutta, for the Month of May 1842.

May.		Observed at 9 h. 50 m.					Observed at 4 p. m.					Rain. Gauges.		Observations made at 8 p. m.				Observations made at 10 p. m.			
			Temperature.			Wind.		Temperature.			Wind.				Temperature.				Temperature.		
Days of the Month.	Moon's Changes.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.
		Inches	°	°	°		Inches	°	°	°		Inches	Inches	Inches	°	°	°	Inches	°	°	°
1		29,810	81,9	83,5	80,3	S. E.	29,706	79,0	79,5	78,0	E.	0,57	0,64	29,80	82,5	82,0	82,75	29,85	83,0	82,75	81,5
2	☾	,753	80,2	83,2	80,0	E.	,694	85,5	89,0	83,6	S.	0,05	0,08	,85	83,0	82,75	82,5	,85	83,0	82,5	81,5
3		,770	81,9	86,5	88,2	S. E.	,713	82,4	80,0	79,0	N.	0,10	0,14	,85	83,0	82,5	81,5	,90	82,5	83,0	81,0
4		,805	81,0	85,4	80,6	E.	,717	83,7	92,0	86,0	N. E.			,90	82,0	82,5	81,5	,90	82,0	82,5	81,5
5		,775	83,0	90,7	85,2	S.	,713	82,7	82,5	80,5	E.			,85	83,75	83,5	83,5	,95	81,5	79,0	80,0
6		,770	81,3	81,4	79,3	E.	,674	83,9	87,8	82,8	S.			,85	82,5	82,0	81,0	,85	82,5	82,0	81,0
7		,734	83,7	88,0	84,0	E.	,649	87,0	93,4	87,2	E.			,85	86,5	87,75	86,5	,85	85,5	86,5	85,0
8		,735	86,9	92,0	86,0	S. W.	,674	90,8	96,0	87,8	S.			,85	86,0	86,0	86,5	,90	87,0	87,0	86,0
9		,733	87,5	90,0	85,0	S.	,650	89,7	92,0	86,4	S. W.			,80	86,0	87,0	86,0	,90	87,0	87,0	86,0
10	●	,678	87,5	91,5	86,0	S.	,570	90,8	97,5	91,0	S. E.	0,11	0,16	,80	86,0	86,0	85,0	,80	85,5	85,0	83,0
11		,634	87,0	91,0	86,4	S.	,545	91,5	96,0	90,0	S. W.			,75	86,0	86,0	85,0	,75	86,0	86,0	85,0
12		,578	88,2	94,2	87,0	W.	,526	93,0	101,0	91,5	S.			,70	86,0	86,0	85,0	,70	86,0	86,0	85,0
13		,605	89,4	95,8	88,5	S.	,558	94,8	99,0	89,1	S. E.			,75	86,0	86,0	85,0	,70	86,0	86,0	85,0
14		,622	88,5	94,0	85,3	S. W.	,546	92,0	100,0	88,0	S.			,75	88,5	88,75	87,5	,75	88,5	88,75	87,5
15		,574	88,8	97,0	87,1	E.	,481	93,4	101,5	88,0	W. S. W.			,75	90,75	90,75	89,5	,75	90,75	90,75	89,5
16	☽	,550	89,7	93,9	86,7	S.	,494	93,0	95,0	88,0	S. W.			,70	89,5	89,0	87,5	,75	89,0	88,75	87,5
17		,594	89,6	92,1	86,8	S. (high)	,549	91,5	94,0	87,0	S. W.			,75	89,0	88,75	87,5	,75	89,0	88,75	87,5
18		,609	89,5	94,0	88,0	S.	,542	92,7	98,7	90,0	S. W.			,75	89,0	88,5	87,5	,75	89,0	88,5	87,5
19		,626	89,9	95,8	87,0	S. W.	,569	95,5	99,0	90,0	S.			,75	89,0	88,75	87,5	,75	89,0	88,75	87,5
20		,693	89,4	93,0	88,0	S.	,646	92,5	96,2	88,0	S.	0,05	0,09	,85	90,5	90,5	89,5	,90	88,5	88,5	86,5
21		,713	89,5	93,0	87,0	S.	,626	91,8	94,0	86,6	S. W.			,85	91,0	90,5	89,5	,75	90,0	90,5	89,5
22		,665	89,0	94,0	89,8	S.	,561	93,2	93,8	88,9	S.	0,57	0,58	,80	86,5	85,0	85,5	,75	85,0	84,0	84,5
23		,625	89,0	91,5	87,0	S. S. W.	,574	91,6	95,5	87,0	N. E.			,75	85,75	85,75	84,0	,75	85,75	85,75	84,0
24	○	,658	87,0	92,2	86,0	E.	,562	93,2	98,5	90,4	E.			,75	87,5	89,0	86,0	,75	85,75	85,75	84,0
25		,690	87,0	92,8	86,1	E.	,578	91,5	98,0	87,2	S. W.			,75	87,5	89,0	86,0	,75	85,0	85,0	84,0
26		,649	89,2	95,9	88,5	S.	,564	94,9	98,6	88,2	S. W.			,75	90,0	90,0	87,0	,75	90,0	90,0	87,0
27		,634	89,6	95,0	88,0	S. E.	,554	95,0	99,2	90,6	S.			,75	90,0	90,0	87,0	,75	90,0	90,0	87,0
28		,634	90,2	95,5	88,0	S.	,521	94,1	100,6	90,0	E.			,75	91,0	86,0	85,0	,75	90,0	87,0	88,0
29		,598	91,0	96,4	90,2	E.	,494	93,3	93,9	88,5	S. E.			,75	90,5	90,0	88,0	,70	90,25	90,0	88,0
30		,574	90,5	95,5	88,4	E.	,500	90,4	92,0	86,6	S. E.			,75	90,5	90,9	88,0	,70	90,5	90,0	88,0
31		,522	89,0	92,1	87,0	E.	,430	82,9	82,0	81,0	E.	0,09	0,13	,65	85,0	85,5	84,0	,65	85,0	85,5	84,0
Mean.		29,665	87,3	91,8	86,2		29,586	90,2	94,0	8,70		1,54	1,82								

N. B. From a comparison of the two Barometers, the Mercury in that at the Dispensary stands 1-10th of an inch higher than that in use at the Surveyor General's Office.

Corrections to No. 8.

Page	514,	for	Koh-i-poombur, ...	*read*	" Koh-i-doombur.
,,	517	,,	Soolimoaun, ...	,,	Soolimaun.
,,	521	,,	Borz, ...	,,	Booz.
,,	524	,,	bet ermed, ...	,,	be termed.
,,	528	,,	conjecturd, ...	,,	conjectured.
.,	530	,,	fact that the offspring,...	,,	fact of the offspring.
.,	,,	,,	pair of male birds, ...	,,	pair of mule birds.
,,	,,	,,	half breed female,.........	,,	half bred female.
,,	585	,,	hills of the foregoing,...	,,	hills as the foregoing.
,,	540	,,	Calculis, ...	,,	Calculus.
,,	,,	,,	*garh*,........................	,,	*zarh.*
,,	**541**	,,	Jhara, ...	,,	Jharal.
,,	,, line 3.	for	Jehr, Jhaar or Jhar,	,,	Tehr, Thaar, or Thar.
,,	,,	,, 7 et seq. for	Jehr, Jhar, &c.	,,	Tehr, Thar, &c.

THE

CALCUTTA JOURNAL

OF

NATURAL HISTORY.

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*Recherches sur les Poissons Fossiles.** *Par* LOUIS AGASSIZ, *Professeur d'Histoire Naturelle à Neuchatel. Neuchatel, (Suisse,)* 1833.

The work of M. Agassiz, from the admirable execution of the descriptions, as well as of the plates, together with the important aid which it affords in geological pursuits, is generally regarded in Europe as a worthy continuation of Cuvier's Researches on Fossil Bones, chiefly of the higher classes of vertebrate animals. The plates are numerous, and afford detailed and satisfactory drawings of from six to eight hundred fossil species, and have been executed by two

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* Containing an introduction to the study of these animals, the comparative anatomy of the organs which contribute to a determination of fossil species, a new classification of fishes expressing their connection with the series of formations, an exposition of the laws of their succession and development during all the metamorphoses of the terrestrial globe, accompanied with general geological considerations; finally, descriptions of above eight hundred species, most of whose characters and forms we have re-established from the fragments contained in the strata of the earth.

talented artists, Messrs. Dinkel and Weber, in a manner at once satisfactory to the zoologist and geologist, from the strict attention paid to the delineation of details, as well as to the colouring. M. Dinkel accompanied the Professor in his travels for the inspection of the Fossil Fishes contained in the various Museums, public and private, throughout Europe.

A mere enumeration of the Museums, in which fragments of Fossil Fishes are treasured, with a notice of the variety and value of the specimens in each collection, constitutes of itself one of the first chapters of the work, and affords a striking instance of the interest with which such objects are regarded in Europe. Every town in the Austrian dominions, Switzerland, Prussia, Holland and France, seems to have its Museum, which in most instances, contributed more or less to the materials of Professor Agassiz. If England has contributed less from such sources, the riches of her strata in fossil fishes, and the liberality of her scientific men, have added greatly to the interesting materials upon which the great work in question is founded. The work is intended to consist of 5 volumes Atlas, with a corresponding number of volumes of folio plates ; 40 pages only of the first volume, 267 pages of the second, 156 of the third, 181 pages of the fourth, and 72 of the fifth volume, together with an Appendix of 117 pages, in all 833 pages of different volumes, and 164 plates are completed. It is now nearly ten years since the first *livraison* of this work was issued, and from the interest and importance attached to it, much anxiety has been evinced for its progress and completion.

Difficult in itself, from the nature of the subject, it is rendered still more so from the materials of which it is constructed being widely dispersed throughout the various Museums of Europe ; so that it is easy to account for the delay with which its completion is necessarily attended, without at all despairing of its ultimate accomplishment.

We take the present opportunity of placing before our readers, the views of Professor Agassiz, relative to the skin and the scales of fishes; because these views, together with some of the terms employed in explaining them, must in future be attended to in all scientific descriptions of fishes. This will be an excuse for the introduction of what might otherwise be thought tedious, and perhaps trifling details.

With regard to the object of the work, we have concluded our present notice with an abstract of one of M. Agassiz's orders of fishes, which we think will do more to make it understood, than the most lengthened remarks we could offer. As we hope by degrees to afford a general analysis of this work, we will not here anticipate the interesting results it affords. It may be enough to say, that the following minute investigation of the scales and skin of fishes, from affording new means of identifying species, has led to the most interesting and important results in Geology, has extended the science of Zoology, and led to the discovery of entire creations, which were unknown to us before. Hence it is, that in the study of nature, no object, however trifling it may seem, is unworthy of attention. Every thing is full of meaning, and when rightly contemplated, whatever we take up, either a scale or a skeleton, is sure to lead to some great principle connected with harmony and unity of design.

Dermatology, and in particular the Scales of Fishes, as compared to the analogous productions of the Skin in other classes of the Animal Kingdom.[*]

As the skeletons, the scales, and the teeth are the only parts which are found in a fossil state, it is necessary in this place to afford a sketch of the structure of these parts, and to explain their peculiarities in different families of the class of fishes.

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[*] *Recherches sur les Poissons Fossiles.* By M. Agassiz, chap. iv. vol. i.

This exposition will serve as a guide to those, who are desirous of becoming acquainted with fossils only, without requiring to enter specially on the study of Ichthyology; and will explain at the same time, all the proper terms which I have used in the description of species. By this means, I shall be able to afford a better knowledge of the exact characters by which to identify in the different classes of the animal kingdom, those detached parts of the organic bodies which may become the subject of investigation, so that any one of no pretensions will thus be able to distinguish a scale, a bone, or a tooth of fishes, from the corresponding parts of other animals, which may be found with them. I have also frequently had occasion to remark, how easy it is to mistake some of these fragments amongst themselves; for example, bones or teeth for scales.

The skin of which the scales are a special production, deserves in all animals particular attention; the study of it has in every way, unfortunately for Zoology, been too much neglected; amidst the *Polypes** and the *Meduse*,† where it is not yet detached from the mass of the body; amidst the *Echinodermes*‡ and the *Molluscs*,§ where it forms the calcareous shell; amidst the articulated animals,|| in which it forms horny rings, and even in fishes, reptiles, birds, and mammalia, where the lamellar scales, the horny plates, the feathers, and the hair, in all assume a peculiar structure, and produce different solid shapes in each class.

It is easy to see the reason of all these modifications, destined to protect the body of the animal against the influences of the external world. The skin is but the result of the action and re-action, which is established between the being and medium in which it is enveloped and lives; and if it be

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* Sea Slugs.—Ed. † Sea Nettles.—Ed.

‡ Sea Eggs, Sea Urchins, and Star Fishes.—Ed. § Shell Fish.—Ed.

|| Insects so called, from the outward covering of their bodies being composed of detached pieces.—Ed.

right to say that the skeleton is, in an animal, a material impression of the spirit that has influenced it during its life, we are enabled to affirm also, that the skin is the result of those conditions that exist between the being and the ambient medium. In this point of view, it partakes on the one hand of the nature of the organization of the animal to which it belongs, and on the other, of the conditions of existence in which it is destined to live. It is, then, the field of action to all external influences, and the means by which all the interior actions are transmitted to it without. It is an organ essential to the animal, an external impression of all the peculiarities of its existence, and of its organization, thus carried to the surface, and submitted directly to the view of the observer; hence from its simple aspect, we are at once enabled at a glimpse to deduce all the details of the structure of an animal which we have never seen, such being the intimate relations which exist between all the organs.

The study under this point of view will then, as it advances, be found to be of very great importance to comparative Zoology, and above all, in the examination of fossils of which we find but an external print.

As the common integuments form the boundary of the several organs, and distinguish at the surface the peculiar forms of animals, before speaking more particularly of the organization of the skin, I should enter here into some details of the general configuration of the body, were I not afraid of departing too far from my subject. I shall merely say, that the figure of any being whatever is determined by the proportions of three dimensions of its bulk, comprised under different aspects in different species.

These dimensions determine also the different regions by which we are in the habit of distinguishing animals. The longitudinal direction establishes the proportions between the anterior and posterior parts, as the head, the breast, the abdomen, and the tail. The breadth we have taken from right to left, whatever may be the irregularity in the proportions of one or other side of the animal, and it is upon these proportions that symmetry depends. The height which here is the thickness, is the differences which exist between the dorsal and ventral regions, or according to the position of the animal, between the superior and inferior parts; essential differences which may be traced up from the separation of the *blastoderm* into a serous and a mucous membrane producing two orders of organs so different in the parts which they are to perform in life.

No other class of the animal kingdom presents these forms in such variation as the class of fishes. There is no other class in which such perfectly spheroidal animals as the Diodons* occur; other species are discoid, or circular, and flat, but this last form presents two conditions very different from the effects of either excessive contraction, or of excessive development of the two sides of the body; for in the first case it is compressed, and very elevated, but also very narrow, as in the Vomers, and the Orthogoriscs; whilst in the second case it is very depressed, flat, and very broad as in certain Rais. Other species are oval, more or less elongated, slender, and compressed on the flanks; this is the most ordinary form in fishes, and hence those which possess it, are called *regular fishes*, such as the Carps, the Trouts, &c., yet notwithstanding the longitudinal direction varies considerably, passing from every possible intermediate state, (in the Pikes for example,) to the elongated fishes, which are sometimes cylindric, (the Eels), sometimes compressed or flat as a ribbon, (the *Cepoles,)* the same of others which have an excessive breadth in comparison with their height, (the Gymnetres and the Ophisures.) Although the forms most fantastic, are those which present surfaces more or less plane, and which are circumscribed by angular figures,

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* The *Cutcutia* (Tetradon cutcutia Buch.) is a familiar example of this form in Bengal.—Ed.

sometimes triangular, square, pentangular, or having the two sides insymmetrical, that is flat on one flank and arched on the other, and with the bones of the head so much disproportioned, that the two eyes are turned to one side of the animal,* (as the Soles, &c.)

The essential character of the skin is to envelope completely the animal, and to form thus a sort of external skeleton for the protection of the surface, as the osseous skeleton protects surrounding internal organs.

In the invertebrated animals, there are no other solid supports than those which are produced by the integuments, or which depend on them; nevertheless, we would be wrong if from that circumstance we were to draw a parallelism with the osseous skeleton of the vertebrated animals, which is exclusively peculiar to these last, and which has no point of analogy with the solid pieces of the inferior classes. They are much more the productions of the skin, that, in the vertebrata represent the skeleton of the invertebrata; and yet we can trace completely the parallism of different degrees of progression in the Animal Kingdom, notwithstanding the considerable differences in the manifestation of analogous parts between the superior and inferior animals. For we observe even more striking differences between the various productions of the skin in vertebrate animals than that which we have just remarked in the invertebrate. As to the rest, it is enough to know, that these metamorphoses of the skin have a peculiar tendency to the surface of the body, and present constant relations between the skin and other systems of organs. However, the skin is not intended alone for the external surface of the body, it penetrates also into the internal cavities which it lines, and on the surface of which, it produces equally the solid parts of different structures, to

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* Several examples of this form are presented by the fishes of India; they are familiar to the fishermen of Bengal under various names, as Pan, Arsee, Nauphala, &c.—Ed.

which are attributed different functions; for example, the teeth and all the horny plates, which in many classes are found on the internal surface of the intestines. Two essential modifications of the skin may therefore be distinguished, and consequently also, two modifications of the dermatic skeleton. The one which covers the external surface of animals, and the other which is developed in their internal surface. These two kinds of skeletons exist together in the invertebrated animals, and present between themselves very intimate and numerous relations and connexions, as we shall presently see; they are seen also in many places passing insensibly into one or other at the superficial openings of the internal cavities of the body. They exist also constantly double in all the vertebrate animals, which have in other respects an interior bony structure encircling the cavities, and round which all the organs are placed.

In this great division of the Animal Kingdom, not only do the two modifications of the dermatic skeleton present numerous connexions, but these again afford intimate relations to the bony skeletons on many parts of the body, where insensible transitions are observed from one to the other; for example, in the fishes, between the opercular pieces and the scales, between the occipital bone, the humerus and the scales, between the teeth and the pharyngeal bones, &c. &c.

It exists besides in a constant antogonism in the development of the three kinds of skeletons I am describing, and of which the parts of the one are increased in proportion as those of the other are less complete in different regions of the body.

No one has yet obtained better information of the different modifications of the skeleton than Carus; no one has examined it in more detail; but no one has explained it in a manner more confused than he has done in his work, on the essential parts of the osseous and testaceous structure.

As to the development of the skin, it is at first seen to be a mere serous film of the *blastoderme,* or first rudiment of the common envelope of the body. In the mean time, the observations which have been recently made on the advanced period of development of the egg, promise soon to prove the serous membrane to be the common basis from which the bones, the muscles, and the skin are equally formed. This is separated again into many lamina, amongst which are distinguished, first the epidermis, afterwards we see the formation of the net of malpighi, the corion, and the subjacent muscular coat.

In the fishes, the skin is always much more tense at the surface of the body than in other animals; uniting to the muscles by a dense cellular tissue, and is never possessed of so much mobility as in other vertebrated animals. In the class we are now speaking of, it is the corion and the solid parts produced at the surface of the malpighien net, that acquires such considerable development under the term of scales. But in order, to afford an accurate idea of the structure of scales, which is to form the principal question for our consideration in this chapter, it is indispensable to know the condition of the different layers which are formed in the integuments of those animals in which the skin is most organised.

First the *epidermis,* the outermost part of the skin, may be regarded in a general point of view as a membraneous lamina of horny substance, which covers the whole surface of the animal, isolates it from the external world, defends the parts of most delicate organization, and which as a bad conductor of heat, preserves to the animal that proportion of warmth which is proper to it. The epidermis is insensible, and is reproduced readily; it is composed of a great number of layers or folds, superimposed and strongly adherent to one another. It is the modifications of the folds of the skin, that is to say, the hair, the feathers, the scales, shells, etc., upon the consideration of which we are more particularly engaged, and which we are about to compare with each other.

The *rete malphigii,* as it is commonly called, is the inner lamina of the epidermis which is not yet become hard, which adheres to the corion, and which is at first soft, and afterwards hardened by means of a secretion from the corion.

The *corion,* in short, is the living part of the skin; it is formed of very hard mucous tissue, and of vessels and nerves; it adheres to the muscles by cellular tissue more or less strong. It is this part of the skin which is the seat of sensation, because of the number of nervous fibres which it receives; it is this which, by means of the net of little sanguineous vessels with which it is covered, secretes the coloured pigments at its surface, produces and supports the other laminæ of the skin; and, in one word, which regulates all the various functions of the surface of the body.

The different tints of the skin are owing to the deposition of different coloured pigments which float between the epidermis and the corion. In those fishes in which they are most abundant, we observe first at the inferior surface of the scales, a bed of pigment of a metallic golden or silvery aspect, and which often produces various brilliant metallic reflections; (it is with this material that false pearls are coloured;) besides this, they have towards the surface of the back, and in general on the upper parts of the body, numerous scattered points, of various pigments, more or less approaching to a black colour, which follow in such abundance, as to produce on the skin the effect of paint. These different pigments are composed of little crystals of different earthy and metallic substances. They are found again on the external surface of the peritoneum, on the brain, medulla oblongata, and in the eyes. Ehrenberg observed them in the Pike, but they exist in all fishes, and present numerous varieties of form and composition according to the species. A very remarkable phenomenon in fishes depending on the abundance of pigments, their differences, and the rapidity with which they are secreted and absorbed, is the changes of colour which belongs to many species at different seasons of the year. In the time of spawning, for example, or rather during their time of growth, or when excited to violent movements, or even after their death, when they have been exposed to different atmospheric influences.

All the species which I have observed, present at the period of spawning, even more vivid and marked tints than usual, the points of coloured pigment that are not ordinarily seen towards the back, are then extended also on the flanks and belly which they embellish. Even the (at other times) uncoloured regions of the body are at this period also covered with various tints; the abdomen, for example, is marbled, and the insertions of the fins are red or orange, and the belly partakes of various shades of these different colours. During the development of fishes, we see also their skin and their fins presenting the most fanciful and brilliant tints, although at the period of their birth they are nearly all white and transparent. In making drawings of living fish, I have yet another curious observation to make on their colouration: it is, that when they are irritated, or exerting violent efforts to escape from their confinement, they present the most animated, as well as the most rich and characteristic of their colours, they become pale, or even completely lose their colours, which they again slowly recover. I have not however observed this fact often in the *Zingel* (*Aspal Zingel*), in the Trout of the rivers (*Salmo Fario*), in the Lotte (*Lota Fluviatilis,*) and in the Silure (*Silurus Glanis.*) To me it appears capable of explanation by the supposition of an abundant secretion and sudden reabsorption of the coloured pigments. After death, all the green parts of fishes very soon change to blue on exposure to the air; thus nearly all blues represented in drawings of fishes are the colours of death. The other tints change in different ways: the red passes frequently to yellow, the yellow becomes black, &c. When left in water after their death, fishes become quite discoloured, yet notwithstanding, if after the lapse of some time they are brought into the air, their natural colour though somewhat faded, returns.* These phenomena of coloration are so much more remarkable, as in certain cases the coloured pigments appear to be very fixed: particularly as they have been found in fossil fishes, in which very distinct traces of the distribution of their colours are preserved in the black pigment, as for example, in the *Platax vespertilio,* Agass. the *Enchelyopus tigrinus,* Agass. found at Mount Bolca. It is this fact which induced me to speak here of the coloration of fishes. I shall afterwards detail all the observations I have made on this interesting subject.

The surface of the body of living fishes is constantly covered with a great quantity of mucous. With some it is little tenaceous, and forms a thinish layer; with others, and particularly with those in which scales are less developed, it is more firm, and forms a thicker coat, for example in the Tench. The fluid is secreted by a mucous gland which extends the whole length of the body, and which is ramified in all the bones of the head; it is conveyed to the surface by numerous pores, which are seen on the cranium and on the bones of the face, on the length of the superior maxillary, on the preopercule, and by a series of tubes which traverse the scales of the lateral line. From these the mucous is spread over the entire surface of the body, as we have proved by drying the surface of fishes with a cloth; after this operation they lubricate themselves anew with mucous, which flows from the pores on all parts of the body.

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* In spirits of wine, fishes ratain their colours much better if previously replaced again for a short time in water, then quickly dried in the air after having been wiped.

An epiderm is constantly found beneath a plastering of this mucous, which last is easily produced by spirits of wine; the coagulated mucous being raised, the epiderm is found, although some authors have erroneously denied its existence in fishes; it is indeed very thin and transparent, and bears a resemblance to the epithelium, which lines the mucous coat of the alimentary canal. Nevertheless, in fishes covered with imbricated scales, it forms of itself the folds which envelope the posterior extremity of each scale, so that it covers as much of the internal surfaces, as of the external; but it is chiefly in fishes whose scales are very small and emersed in the skin that its existence is easily demonstrated, on raising the coagulated coat of mucous formed by alcohol, and with which it is covered.

From the foregoing considerations, we are also to regard the teeth as dermatic formations, of which the bulb is a species of malpighien gland, and which might be treated of in this place; but I prefer referring their examinations to the head of Osteology, on account of some observations on their growth in different modifications of the dentary system, which I would wish first to conclude, so as to be able to refer to certain peculiarities of the skeleton with which it is necessary to be previously acquainted, in order that the singular disposition presented by the teeth may be treated more completely in connection with the point of their insertion.

The scales of the greater part of fishes are imbricated one upon another as tiles: that is to say, those of the anterior series rest their posterior border on the anterior border of the series following; and this imbrication still leaves uncovered a part of the scales more or less considerable, not alone of their posterior border, but also of their superior and inferior borders. This overlying gives to the scales their apparent form, which is very often quite different from their true contour; for an oblong scale is covered so far in front and rear, that its height may seem to exceed the length, just as a broad short scale would appear more long than high, from the superior and inferior border being much concealed by the imbrication before and behind. It is also necessary to distinguish the different modes of imbrication: the most simple is that where the scales of each transverse series have simple joinings by the superior and inferior borders, without being overlapped in their anterior part by the middle of the posterior border of the scales of the series which precede. We observe this disposition in nearly all the *Ganoids,* with this difference only, that sometimes the scales of the consecutive series alternate the one with the other, so that the superior and inferior borders of an anterior series correspond to the middle of the scale of the following series, for example, in the anterior parts of the trunk of the *Lepidosteus,* t. xi. f. 1 and f. 3, so much of the borders are placed in a line with one another, as for instance in the posterior part of the trunk of the *Lepidostes,* f. 6, or rather they are brought but little over towards the superior or inferior part of the following scale, as in the *Polypterus,* f. 2. Sometimes the upper and lower borders of two scales appear to have simple juxtaposition, and are applied one against another to their square sides, for example t. xi. f. 6, 7, 8, or rather they have their edges cut so as to fit diagonally between the superior and inferior borders in a manner to afford the most intimate union in their partial superposition; for example, t. xi. f. 3, 4, 5, or lastly, the superior border of one scale is provided with a very salient hook or crochet, which corresponds to a hollow in the lower border of the superior scale to which it is fixed, such are the scales, fig. 9, 10, 11, 12, and 13.

Another mode of imbrication, is that where the scales do not overlap by means of anterior and posterior series, but yet wherein each series, each superior scale covers with its inferior border, a portion more or less of the superior border of the inferior scale. Generally, when the imbrication advances in this way, and the scales appear in straight lines, it produces sometimes a longitudinal series of scales, to which we give the name of *lateral line*, which is found to be composed almost entirely in this manner, as in the *Pike*, the *Corègones*, etc.

Numerous modifications in the external aspect of scales result from the form of their imbrication, depending on the degree of alternation of the scales in their successive dorso-ventral series; for, according to the inclination of these series, a superior scale of any one series may be sufficient to cover simultaneously with an inferior scale of the preceding series a great portion of the two sides of the adjoining scales, according to the degree in which they are drawn together; for example, as seen in the Leuciscs and our Perches. The scales which are not imbricated, are either very small and plunged into the skin in a manner to render them imperceptible to the naked eye, or they assume the form of shields or darts, sometimes standing equally over the whole surface of the body (the Diodons); sometimes they are overlapped diagonally or in a tesselate form, (the Coffres;) or finally, they form peculiar series in certain parts of the body, while the rest of the surface is furnished with other scales, (the Sturgeons, the Raies, etc.)

The form of scales depends also greatly on their position; it is necessary therefore to attend particularly to the position of the series from which they have been taken, especially with regard to imbricated scales. These series are disposed obliquely one behind the other, from the ridge of the back to the middle of the belly. To this series we apply the term *dorso-ventral series.* Generally, in each of these the dorsal scales are smallest, those of the middle and flanks are the largest, then they diminish again in size, and it is on the lower parts of the body that they are observed the smallest of all; but there are exceptions to this general disposition, and sometimes the lowest scales are the largest.

Almost always it may be remarked, that towards the middle of the series, one scale of a peculiar conformation is perceived to be perforated with a hole, and which with others of the following series forms a range of peculiar character, placed on the middle of the sides, and to which the very improper term of lateral line is given. This longitudinal range separates all the scales of one side of the body into two fields, which present often the most striking differences in their aspect.

The superior field is generally occupied by the smaller scales, particularly in the Perches and the Chetodons, and their imbrication is such, that they are more easily distinguished in the oblique series, which, with regard to the lateral line is directed upwards and *backwards* towards the back, than they are in the series in which they are directed upwards and *forward* towards the back; whilst in the inferior field it is the reverse; in the oblique series, in the direction backward and downwards, they are more visible than in those which are turned forward.

These different directions of the series are more or less perceptible in different families. However, we can always recognise the two kinds of series which cross the lateral line: the one, and that generally the best marked, in the *Ganoïdes* and *Cycloides,* is directed from the middle of the back to the middle of the belly, from before backwards and from above downwards, in the same direction in the whole extent; the others, directed from behind forward and from above downwards, crossing the lateral line also with the preceding. It follows from these observations, that it is necessary to distinguish still farther these half-series, superior and inferior, by particular names, and I call the *medio-dorsalis* series those which extend from the lateral line to the back, and I distinguish the series *medio-dorsalis, anterior* and *posterior,* according as they indicate a direction forward or backward; and as it is the lateral line which appears to establish these differences, it is that which I start from in their appreciation. Thus in the *Polypterus,* t. xi. f. 2, I gave the name of the series, *medio-dorsal posterior,* to that which proceeding from the fourth scale of the lateral line arrives near to the first ray of the dorsal, and to all those which follow the same direction, *et vice-versa* that of *medio-dorsal anterior,* to the series which, from the ninth scale of the lateral line, extends to the same ray. It will be the same of the series below the lateral line which I have called *medio-ventral;* those which extend backward and downward from the lateral line, are the *medio-ventral posterior;* and those which are directed upward and forward, the *medio-ventral anterior.* The necessity of distinguishing these series and their different directions, will be better understood when we enter upon the description of the scales of fishes of the families of Percoids, Sparoids, Chetodons, &c., because these half-series not being always equally marked, give to fishes their various aspects according to the salient disposition of the scales. This method presents still another advantage. It leads to an intimate acquaintance with the relations which exist in a great number of fishes, between the position of the scales and the disposition of the skeleton. We remark in general, that nearly all those fishes with large scales have the same number of series of scales as of vertebræ ; those of the series which are most remarkable have them in the same direction with the spinous apophyses of the sides of the skeleton. This is very striking in the Leuciscs and in some Percoïds ; the series *medio-dorsalis posterior* correspond exactly with the superior spinous apophyses ; the series *medio-ventralis posterius,* which forms a very wide angle with the preceding, corresponds, on the contrary, to the sides of the inferior spinous apophyses. Whatever be the nature of this analogy in the disposition of the parts of the skeleton and the scales, it is not always thus sensible, though traces of it are almost every where found, as we may perceive from the Tables A, &c. Vol. ii. Attention to the plates of the following livraisons will afford still better examples of this analogy.* We found again in many fishes peculiar ranges of scales on the middle of the back or of the belly, at the insertion of the fins extending vertically with the fin rays.†

From all the possible modifications in these different combinations, it follows, that there must be a very great variety in the external aspect of scales; yet they present always the same organization, and may be all regarded as branches of one fundamental type, whatever may be their apparent form, or whether they are imbricated or not; whether they are thin and formed only, some of small horny laminæ, or thick and at the same time osseous plates. It is very easy to examine these analogies in all the modifications which they present in the different families of the class, however numerous and however varied they may be. It is not, however, my object in this place to stop to describe all the forms which exist. These details will be found in the following volumes

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* In examining attentively the plates of this work, *(Recherches sur les Poissons Fossiles,)* and comparing them with nature, my readers will be convinced that in all the fishes which I have represented, the scales are figured in their natural position, and with their characteristic form. I have made this remark particularly, because the greater part of plates which exist, are in gross violation in this respect, of laws the most constant and precise.

† The most remarkable instance of this peculiarity occurs in the genus *Schizothorax* of Heckle, in which the lower ventral ranges of scales separate some distance in front of the anal fin, leaving a naked membranous space in which the outlet of the intestine is placed. The group in which this peculiarity occurs belongs to the mountains of India, and was unknown to M. Agassiz, at the time the above was written, otherwise be would probably have thought it deserving of some special notice. He will since have become acquainted with it, however, from the work of M. Heckle on the fishes of Cashmere.—Ed.

of the work; it will be sufficient to point out the principal modifications of the general type, and to afford a few examples of their secondary variations.

Some genera of fishes have no scales whatever, nor even parts analogous; the epidermis in that case rests immediately on the layer of pigment which colours the skin; such are the *Myxines*, the *Pteromyzons*, etc. In the greater part of these fishes, however, the scales are more or less developed, and their position, their form, their consistence, and the nature of their surface varies to an infinite degree. They are contained in the mucous cavities, or little pouches, formed by the corion, to which they are not however attached by vessels. Supported in their position by a duplication of the *epidermis,* which embraces their posterior border, they are formed of plates, or horny or calcareous leaves, superimposed one upon another, and which are secreted from the surface of the corion; these leaves are each successively attached to the surface of the preceding leaves to which they are united by hardened mucous. To form a just idea of their development, it is necessary to examine them first in those genera of fishes in which the scales are disposed in the most simple state; for example, in the Eels, the Blennies, the Loaches, and the Leuciscs. These fishes are remarkable for the cells of the corion in which the scales are found; the anterior border, (that which in other cases is usually imbricated,) is free and unattached to the adjoining part of the cellule of the scale, its posterior border, on the contrary, is contained in a fold of the epiderm which covers the outer surface of each scale, and which, passing by the posterior border of the internal surface, a part of which it also covers, is continued to the external surface of the following scale, and thus forms the beds of the corion in which the scales are supported, as may be seen in figure 8, t. xi.

Thus the posterior border of each scale is fixed in a fold of the skin; that which is to follow in the superposition, or the imbrication of the scales, appears to be free, and is generally found to be so, whilst the anterior border is covered by the preceding scale which advances freely in its cellule. When we detach a scale from the body of a fish, we necessarily raise the fold of the epiderm which fixes it to its cavity, it is owing to this that at first sight the posterior border of scales always appears so different from the anterior border. We have remarked in fact on the external surface of each scale, or the part which advances into the cellule, a great number of concentric lines so much the more visible as they approach the centre. But when the epiderm of the posterior border is raised, the lines are found to be similarly concentric, and thus it is easy to see that the concentric lines of the anterior and posterior borders are continuous with one another. After macerating the scales for some time in common water, they appear to be easily divided into a great number of plates or leaves, more or less thick, and of different sizes, but which are all of the form of the scales: these leaves are superimposed in such a way, that the smallest occupies the centre of the scale, and forms its outer part, whilst the larger succeeds the smaller, successively, and is soldered to its inferior surface: thus it is evident, that the concentric lines which are visible on the outer surface of scales, are simply the borders of the leaflets of which they are composed. Thus the reason why the inner surface of scales should always be smooth is, because the last leaf of which it consists, extends beyond the borders of all the others. A correct idea of the structure of scales may thus be formed by conceiving them to be so many flat cones with broad bases, consisting of a succession of plates, the smallest occupying the summit, and the largest composing the base of the cone; only in representing them thus, it should not be forgotten, that it is the summit of the cone which exists first, and thus it is by its inferior surface or its base, it extends in its growth. We have confirmed these observations by comparisons between a great number of different examples of scales of all ages of one and the same species of fish. They will form in this way a series presenting all degrees of development of the scales, that we are able to observe in one individual during all the periods of its growth. We learn also from this, that the number of leaves which compose a scale, do not correspond with the age of the fish, and that in different species it is formed of a different number of laminæ of growth during a year; we find also, that the growth of scales is periodical; that they are not formed continually without interruption, but that there are, according to the species, different seasons of the year more favourable to their development, during which they form all the leaflets they present for the increase of the year. After the consolidation of the new leaves, they remain a long time, during which they are not disposed to form new laminæ; the last lamina shortening itself tends more or less to the border, and forms a species of hook, very inconspicuous it is true, but which becomes more prominent when the leaves of new growth are joined to it the following year; and they are then seen at the surface of all the scales, as so many concentric zones, more marked in proportion to the years the fish has lived. As these zones are found equally visible on the scales of fossil fishes, it will, in time, become the means of determining frequently the age which has been attained by fossil species.

It would be a great advantage to geology, if all the information that collections of fossils are calculated to afford, could be had relative to the respective ages attained by the ancient beings whose remains are found in the crust of the earth. If we were at first to study zealously the relations which exist between the leaves of growth in the shell of the mollusc as compared with the age of the animal, and then extend these inquiries to the growth of the vertebræ, to the development of the plates, and the spines of the echinoderms, to the cellules of the polyps, we might hope that a day would not be far distant when we should obtain by this means a glimpse of the duration of the creations, which have successively enlivened the surface of our globe. In presenting the geological results of my researches, I have become acquainted with facts which I have already arranged with regard to the class of fishes. As to the Molluscs, the species whose shell is ornamented with spines, pores, channels, and enlargements regularly disposed on the surface, are the most adapted to initiate us into an acquaintance with their age, as *Cardiums, Chamas, Ranellas, Tritons,* the *Murex's, Scalaris's :* the partitions of the *Nautilites,* of the *Ammonites,* and in short, the number of whorls in the outline of the spire of all the species, will yet be sufficient to serve as a term of comparison. The determination of the relative age of analogous species in the different successive geological formations, will present the most curious results. Science besides would derive from such researches the advantage of reducing considerably the number of species, and above all, of pointing out those differences that depend merely on age.

All the modifications that we observe in the form and nature of the surface of scales, proceed from the form of the leaves of growth, and the manner in which they are superimposed one upon another. Nevertheless it must not be forgotten, that there are scales (in the Ganoïdes,) on the external surface of which layers of enamel are deposited in proportion as the leaves of growth are extended, like the enamel of the teeth which covers their crown, while deficient on the bony layers which form their roots.

The outline of scales varies infinitely in different species of fish, and we even observe the difference of form to be considerable in each individual, according to the place which they occupy on the body. By degrees they become round or oval, or more or less angular, having their centre of increase(1) in the middle, and then all the leaflets are placed one upon another, and equally bordered in every side(2) ; they may again possess this same form, but the centre of growth approaching more or less to one or other border, the concentric lines are then removed more to one than to the other side, being closest on the side at which the centre of increase is placed ;(3) occasionally the contour presents sinuosities, the lobes of which being more or less large, and conspicuously marked, when the leaflets of growth present these forms, and they are superimposed exactly one over another according to their size; (4) it is particularly on the anterior border of the scales that we observed these large undulations. When these lobes are acute in the form of denticulations, or very sharp serratures, and which are only found on the last leaflet (the preceding leaflets presenting a successive disparity in bluntness,) it follows that such scales will have their border simply serrated ;(5) but whenever it is found on the border of many leaflets consecutively, the border of the scale and all the visible external surface of the same presents numerous ranges of bristling prickles,(6) they are then very rough to the touch. It is the same when the borders of the leaves

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(1) I thus name the part of the scale where the first lamina is secreted in the *alveolus.* I call it also the centre of radiation, when encircled by the delineations which ornament the surface of the scale.

(2) Voyez dans mon selecta genera et spec. Piscium Brasiliensium, Tab. D., les écailles du Rhaphiodon gibbus, and Tab. E. those of Coryphœna immaculata.

(3) Voyez selecta genera Tab. E. Cynebium maculatum et Caraux lepturus.

(4) Myletes bideus ; Saurus longirostris, intermedius and truncatus.

(5) Selecta genera, Tab. D. Rhombus ocellatus, et soleæformis : Tab. F. Corniger spinosus.

(6) Selecta genera, Tab. D. Plogusia brasiliensis.

are not sufficient in thickness to relieve the intervals from space to space of one side,(1) as we see also in some species of Tellines. It is always at the posterior border of scales that we observe on the sides of the leaves of growth, those points to which, according to their form we have given the names of *ciliæ, denticules, spines,* and also of *ridges;* and as it is this part of the scale which is visible on the surface of the fish; it is also to this disposition of the scales that the asperities of the skin in the Perches, the Chetodons, and the Pleuronectes, is owing; in these the inequalities in question are most prominent. It is no objection whatever to this, that their anterior border may not be more or less lobed, as it would be all the same if it were perfectly smooth.

When the scales have acquired a certain development, and their external surface has been consequently for a long time in contact with the enveloping medium, it frequently happens that the first formed filaments desiccate, harden, and are detached from the middle of the scale, under the form of little irregular palettes or spangles, which render the central parts very unequal, and give to them quite a different aspect from that which belonged to them when the fish was smaller. Nothing can illustrate these changes better, than the scales in old Carps when compared with young individuals.

There is yet one peculiarity in certain scales which tends to render their surface unequal; namely, a number of furrows which extend in different directions from the centre of growth, or some other part of the scale to the border,(2) which they do not however always reach.(3) In some species

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(1) Selecta genera, Tab. F. Mesoprion, Corvna, Pachyurus.

(2) Selecta genera, Tab. C. Erythrimus unitœniatus, Tab. F. Batrachus punctatus, Lobotes ocellatus et Mesoprion.

(3) Clupanodon ausens, Chalceus angulatus.

it is ramified.(1) Sometimes these furrows do not commence where the scale is composed of many leaflets; for example below the middle of its radius;(2) or more towards the centre of the scale is occupied by the thick leaflets with hardened edges, to which only the furrows extend,(3) or rather the middle of the scale is covered with furrows which are interlaced and form a net, which in other species extends over the whole scale. The leaflets are otherwise perfectly smooth on the whole extent of their surfaces by which they are joined to one other. The furrows are not extended beyond the outer margins of the leaflets of growth; they are the canals to the border of the external surface which communicate from one leaflet to another: they are multiplied during the growth of the scale, and give rise to all the variations which we have described. The disposition of the furrows varies also the reflections of the fish.*

Abstract of the families, genera, and species of the order of Ganoïdes. Rech. sur les Poiss. Foss. chap. i. vol. ii.

1*st* Ord.—GANOIDES, Agass. (Goniolepidoti, Agass.)

I place the order of Ganoids at the head of the class of fishes, because of their great peculiarities as compared with the types of the families now predominant. However the order of Placoids is even still more distinct from existing forms; but I have not yet had sufficient opportu-

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(1) Selecta genera, Tab. C. Clupanodon aureus, Tab. D. Chalceus angulatus.

(2) Chichla labrina.

(3) Serrasalmo Piranha.

* The chapter here breaks off abruptly; but although incomplete, these details may be sufficient to show the care with which the principles have been examined on which Professor Agassiz's classification is founded. We shall now afford some examples of the manner n which those principles are applied, and of the results obtained rom them in Geology, as well as in Ichthyology.—Ed.

nity to make myself acquainted with the species, (in general very badly preserved), to enable me to trace their organization throughout all the geological formations, in a manner so complete as the order of Ganoids, I have therefore commenced with this division, whose species belong to the coal formation.

Scales angular, rhomboidal or polygonal, formed of osseous or horny laminæ, covered with enamel.

The families are the Lèpidoïds, the Lauroïds, the Pycnodonts, the Sclèroderms, the Gymnodonts, the Lophobranchs, etc. etc.

1*st.* Family.—LEPIDOIDES, Agass. (Lepidostei, Agass.)

Teeth crowded (*en brosse*) in many rows or one only range of little obtuse teeth. Scales flat, rhomboidal, parallel to the body, which is all covered. Skeleton bony.

A. Body elongated, fusiform; superior lobe to the caudal vertebræ longer than the inferior,* all the teeth crowded. The genera are, *Acanthodes, Catopterus, Amblypterus, Palæoniscus*, t. xii. f. 1. and *Osteolepis.*

B. Body flat, and large:

1st. Superior lobe to the caudal vertebræ. The genera are, *Platysomus*, and *Gyrolepis.*

2d. Tail regular: the genera are *Teragonolepis, Dapedius.*

C. Body elongated, fusiform; tail forked or round; genera are, *Semionotus, Lepidotus, Pholidophorus, Microps*, and *Notagogus.*

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* This gives the peculiar obliquity to the base of the caudal fin observed in figs. 1 and 2, plate 12. M. Agassiz has observed that this obliquity depending on the proportional development of the upper and under appohyses of the vertebræ, is confined to the fossil fishes of the coal formation. Those species in which the obliquity is most prominent, have lived at the most remote period of the coal formation, and from thence the peculiarity gradually diminishes as we ascend in the series of strata up to the chalk formation, where it is no longer observed in the fossil fishes of that period.—Ed.

2nd. Fam.—SAUROIDES, Agass.

Teeth conical, pointed, alternating with tufts of little teeth, scales flat, rhomboidal, parallel to the body, which is all covered. Skeleton bony.

A. Body elongated, fusiform; superior lobe of the caudal vertebræ longer than the inferior; *Pygopterus.* t. xii. f. 2. *Acrolepis.*

B. Body elongated, fusiform, caudal regular. *Ptycholepis Sauropsis, Pachycormus, Thrissops, Uræus, Leptolepis, Megalurus,* and *Macropoma.*

C. Body very elongate, cylindrical; caudal regular; jaws prolonged. *Saurostomus* and *Aspidorhynchus.*

3rd. Fam.—PYCNODONTES, Agass.

Teeth a little flattened or round, in many ranges, scales flat, rhomboidal, parallel to the body, which is all covered. Skeleton bony, body flat, large. *Placodus. Sphærodus. Pycnodus.* t. xii. f. 3. *Gyrodus* and *Microdon.*

4th. Fam.—SCLERODERMES, Cuv.

Palatine arch immovable; muzzle prominent, armed with some distinct teeth. Scales flat, and formed in large rhomboidal or polygonal plates placed obliquely to the body, which is all covered. Skeleton fibrous, but little ossified. *Ostracion.*

5th. Fam.—GYMNODONTES, Cuv.

Palatine arch immovable; jaws covered with an ivory sheath formed by the union of teeth. Scales raised to points or hooks. Skeleton fibrous, ossification slight. *Diodon.*

6th. Fam.—LOPHOBRANCHES, Cuv.

Branchies united in little round tufts. Body elongate, angular, covered with angular plates; muzzle tubular, terminating by little thin jaws. Skeleton osseous.

These are the leading groups of one of the orders of M. Agassiz, which is placed at the head of the class of

Fishes, because of their being very distinct from the families which now predominate.

Of the families of this order, some are composed of living Fishes, as the *Goniodonts,* Agass. the *Siluroids,* Cuv. and the *Accipenser,* Agass.; but the great bulk of the species composing the order are extinct; and are found throughout all the geological formations, from the coal measures upwards. M. Agassiz found but one single fragment, which could be referred to any of the species of this order in beds anterior to the coal formation. To take the families as they stand in the preceding synopsis, all the genera of the family LEPIDOIDS are found in beds anterior to the Jurasic formation,* and have no representative species now existing on the earth. The family consists of 11 genera, as already enumerated; of the first of these, namely *Acanthodes,* one species is found in the coal formation at Saarbruck. Of the 2d genus *Catopterus,* four species are found in the slates of Caithness. Of the 3d genus *Amblypterus,* Agass., one species is found at Ceara in the Brazils, and four in the coal formation at Saarbruck.

Of the genus *Palæoniscus,* Agass., six species are found in the coal formation; one in the coal formation of America at Sunderland in Massachussets, and Westfield in Connecticut, and five in that of Europe, chiefly at Munster-Appel, and at Muse near Autun; three are found in the Zechstein†

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* This is the foreign equivalent of our English Oolite, which, on the continent assumes a calcareous character, and constitutes the principal formation of the Jura mountains. The Oolite occupies an intermediate position between the chalk and New Red Sandstone formations.—ED.

† The *Zechstein* is the German equivalent of the English magnesian limestone, it forms the lowest series of the New Red System, and rests immediately on the coal measures.—vide Cal. Journ. Nat. Hist. vol. i. p. 45.

It is necessary to refer to these synonyms in order to show how the fossil fishes of the same genera are always found in the same groups of strata, in whatever part of the world they occur.—ED.

near Mansfeld, and one in the magnesian limestone of England at East-Thickley. All the species of this genus which are found in the coal measures M. Agassiz remarks, have their scales smooth; and those from the Zechstein, have them striated.

Of the 5th genus, *Platysomus*, Agass. four species are found in the Zechstein of Mansfeld, three in the magnesian limestone of England, and three species of a closely allied subgenus *Gyrolepis*, Agass., are found in the Muschelkalk,* of Lunèville and Schwenningen.

The 6th genus, *Tetragonolepis*, Bronn, affords six species from the lias of Lyme Regis and other parts of England, and Neidingen and Seefeld on the continent, and one species from the inferior oolite at Caen. With regard to this genus, the bituminous slates of Seefeld were formerly referred to what were called transition rocks, but M. Agassiz believes them, from the nature and structure of the Fossil Fishes which they contain, to be more recent than the Jurasic deposits, and even posterior to the chalk.

The 7th genus, *Dapedius*, De la Bech. contains two species, one from the lias, and another from an undescribed Jurasic structure.

The 8th genus, *Semionotus*, Agassiz, affords four species, one from the Brazils, its geognostic position unknown, two from the lias in Switzerland and England, and one from the Keuper,† or the coarse lias of Coburg in Saxony.

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* *Muschelkalk* is a limestone which is wanting or absent in the English New Red Sandstone, but which belongs to that age. Its geognostic position is intermediate between the saliferous marls and the next lower group of English strata called Red Sandstone and quartzose conglomerate; vid. Murchison's Sil. Syst. p. 30. and Calcutta Jour. Nat. Hist. vol. i. p. 20.—Ed.

† *Keuper, Marnes irisees* of the French, are foreign synonyms of certain beds of the English saliferous marls, or upper beds of the New Red Sandstone; vid. Murch. Sil. Syst., p. 26. and Calcutta Jour. Nat. Hist. vol. i. p. 20, 45.—Ed.

The 9th genus, *Lepidotus*, Agass., contains fourteen species, four of which are from the lias near Boll in Switzerland, Seefeld and Wirtemberg on the continent, and Northampton and other places in England; two from Jurasic limestone; the remainder are from the Green Sand of Hastings and Tilgate forest in England, and the Morea; and Portland rocks, and one from the Calcaire Grossier* of Paris.

The 10th genus, *Pholidophorus*, Agass., affords five species, four of which are stated by M. Agassiz to be from the lias of Lyme Regis, and three from that of Seefeld, and the fifth from the Zechstein of Sohlenhosen, and the fragment of a sixth species has been found in the lias of Oberland.

The 11th genus, *Microps*, Agass., consists of a single species in the lias of Seefeld.

The 12th genus, *Notagogus*, contains three species; two found at Naples, and one in the Zechstein of Sohlenhosen.

The genera composing the SAUROIDS, or second family of the Ganoids, like those we have just gone over, have nothing corresponding with them in the present creation. Those in which the superior lobe of the caudal vertebræ is elongated, lived anterior to the Jurasic deposits, being found in underlying, and those in which the caudal is uniform, existed afterwards, being found in overlying, rocks.

Of the 1st genus, *Pygopterus*, Agassiz, one species belongs to the coal formation, and is found at Saarbruck; two are found in the Zechstein of Mansfeld, Nendershausen, Riegelsdorf, and Muse near Autun; and a fourth in the magnesian limestone of East Thickley.

The 2d genus, *Acrolepis*, Agassiz, contains but a single species from the magnesian limestone of East Thickley, and

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* The *Calcaire Grossier* is a tertiary formation "exhibiting the first dawn of the existing state of the animal creation," with, as in the present instance, some of the last traces of an earlier creation. It is placed next above the plastic clay.—ED.

the 3rd genus also consists of but one known species, the remains of which are found in the lias of Boll in Switzerland.

The 4th genus, *Sauropsis,* comprises but two established species : one from the Zechstein of Sohlenhosen, the other from the lias of Wirtemberg and Baden. The 5th genus, *Pachycormus,* Agassiz, affords three species, one from Sohlenhosen, and two from the lias of Beaune in Bourgoyne and Wirtemberg. The 6th genus, *Thrissops,* Agassiz, two from Sohlenhosen, and one of a Jurasic structure, but locality unknown. The 7th genus, *Uræus,* Agassiz ; consists of five species, all from the Zechstein of Sohlenhosen ; the 8th genus *Leptolepis,* Agassiz, consists of seven species, of which four are from the lias of various parts of Europe, and two from Sohlenhosen. The 9th genus, *Megalurus,* Agassiz, is founded on a single species found at Sohlenhosen. The 10th genus, *Saurostomus,* is founded also on a single species from the lias ; and of the 11th genus, *Aspidorhynchus,* Agassiz, one is from the lias, and two species from Zechstein of Sohlenhosen.

The 3rd family, or Pycnodonts, like the two preceding families, has no one representative in the present creation. Those genera in which the superior spines of the caudal vertebræ are elongated, causing a corresponding elongation in the upper lobe of the caudal extremity, are anterior to the Jura deposits. The first genus of this family, *Placodus,* Agassiz, embraces two species, one from the Muschelkalk at Bayreuth, and one from the Grès Bigarrè at Deux Points.

Of the 2nd genus, *Sphœrodus,* Agassiz, one is found in Zechstein at Sohlenhosen ; one above the Jura formation ; two in the chalk formation ; and two in the tertiary beds at Aix and Lonjameau respectively. The third genus *Gyrodus,* Agassiz, comprises five species ; two of which are found in the upper Jura rocks ; one in the chalk of Caen and at Baden, and one in the Speeton clay, Yorkshire ; and one locality unknown. The fourth genus, *Microdon,* Agassiz, comprises four species all from Sohlenhosen. The fifth genus, *Pycnodus*, Agass., contains one species from the middle Jura, Yorkshire, and Normandy; four from the chalk of Caen, Belgium, Kent, Maestricht, &c.; two from Mount Bolca; and one from the Green Sand of Tilgate forest.

The 4th family GYMNODONTS, Cuvier, is composed of genera of the present creation, only one species being found in a fossil state.

The 5th family, SCLERODERMS, Cuvier, affords no instance of extinct genera, and like the last, but a single instance of extinct species.

The 6th family, LOPHOBRANCHS, affords no fossil genus, and but two extinct species.

Thus the 1st order of Fishes affords six families, the three first of which are composed entirely of extinct *genera*, of which above 120 species have already been described and figured by M. Agassiz. The remaining families afford no instance of an extinct genus, and but few of extinct species, even in the newest and most superficial covering of the earth.

The extinct genera would thus seem to be almost as numerous and diversified as the living; and appear to indicate amongst themselves several distinct creations, in as much as those forms which are found in the old Red Sand stone, do not exist in the rocks of the coal formation; while those which lived during the period of the coal formation, gradually became extinct, and gave place to others which flourished for a time, and in their turn also finally became extinct during the Oolitic formation. These were followed by other forms whose remains extend throughout the chalk. Still more recent creations, approximating more to the character of existing forms, are entombed in tertiary formations, and it is only in the newest tertiary or most superficial layers of the present surface, that the remains of existing genera are found.

(To be continued.)

Faraday's Experimental Researches in Electricity. *By Lieut.* R. B. Smith, *Bengal Engineers.*

[Third and Fourth Series.]

From the very commencement of his Researches, Faraday appears to have formed the most comprehensive idea of the conclusions to which they were destined to conduct him, and it is evident from many internal evidences, that the ground-plan (so to speak) of his labours, was apprehended by him in so clear and distinct a manner, that from the first, his mind refused to be satisfied with leaving even the slightest obstacle that would interfere with the perfect symmetry of the structure he contemplated raising, unremoved.

In accordance with this state of feeling, he undertakes the laborious train of research, detailed in his third series, to satisfy himself of the identity of electricities derived from different sources, since, to employ his own words, the progress of the electrical researches he had the honour to present to the Royal Society, had brought him to a point, at which it was essential for the farther prosecution of his inquiries that no doubt should remain as to the identity, or distinction of electricities excited by different means. Nor was this a step of minor importance, for although an impression favourable to such identity certainly did exist in the mind of the generality of scientific men, it was vague and indistinct, and had no sound claim to admission among established scientific truths; doubts of different kinds and in different degrees being over the question, and even up to the date of the publication of Faraday's third series, and in the number of the Philosophical Transactions immediately preceding that in which it was published, efforts had been made by distinguished electricians to establish distinctions between electricities derived from different sources. To have left the question undecided would therefore have placed Faraday in the position of a general advancing into a new region, and leaving a strong post unsubdued in his rear, by which the integrity of his movements would have been destroyed, and the prospects of his ultimate success rendered unsatisfactory, because uncertain. In a spirit of the soundest policy, however, he delayed his advance until the obstacle in question had been satisfactorily removed from his path, and of the means adopted by him to this end, we may now proceed to give a rapid sketch.

The various phenomena exhibited by Electricity may, for the purpose of comparison, be arranged with two divisions; namely, those connected with electricity of tension, or what we may venture to call, statical electricity, and those connected with electricity in motion, or dynamical electricity. The effects of the first, at rest, are either attraction or repulsion at sensible distances; of the second, 1st evolution of heat; 2nd magnetism; 3rd chemical decomposition; 4th physiological effects; 5th spark. The mode of proceeding adopted by Faraday was to compare electricities from different sources by their power of producing these effects, and in the event of identity of effect being established, he was, of course, warranted in inferring identity of cause.

The first step was to ascertain in how far voltaic electricity corresponded in its effects to the standard above adverted to, and as it is well known that the discharge of ordinary electricity through air by means of points, its transmission through highly rarefied air, and also through heated air, as for instance a flame, are effects due to its state of high tension, similar effects were sought for with voltaic electricity under the same circumstances; the deflection of the galvanometer, or the occurrence of chemical decomposition being employed as the tests of the passage of the electricity. On endeavouring, however, to procure indications of a discharge by means of very fine points carefully arranged and approximated both in air and in an exhausted receiver, from a battery of 140 pairs of plates, which was capable of deflecting the gold leaf electrometer about one-third of an inch, no such indications could by any possibility be obtained. In this result, however, there was found to be no discordance between ordinary and voltaic electricity, since when a Leyden jar was charged so as to produce a deflection of the electrometer equal to that mentioned above, the points were found equally unable to discharge it with such effect as to produce either magnetic or chemical effects. Hence then, the influence of points proves in so far identity, instead of difference, between common and voltaic electricities.

Heated air was then employed as a means of discharging the electricity of the battery, and the clearest evidence of the passage of the fluid between the two platinum points terminating the apparatus employed, was obtained, both by chemical decomposition and magnetic influence. The instantaneous charging of a Leyden jar, by the application to a battery is another decisive proof of the tension of voltaic electricity.

In motion, the electricity of the battery produces all the effects mentioned in the standard of comparison, and its powers of evolving heat and magnetism, of producing chemical decomposition, physiological effects, and a brilliant spark—the most brilliant indeed that man can obtain, by artificial means—are familiar to all. It satisfies therefore in the most complete manner, the various conditions of the comparison.

Before proceeding to the examination of ordinary electricity, Faraday considers it necessary to define certain expressions, which subsequently come much into use. These are first, the term *current*, by which he understands any thing progressive, whether it be a fluid of electricity, or two fluids moving in opposite directions, or merely vibrations; or speaking more generally still, progressive forces. And second, the term *arrangement*, by which is understood a local adjustment of particles or fluids, or forces not progressive.

These definitions premised, ordinary electricity now comes under consideration; and in regard to its tension, little more is necessary than the simple statement of its existence, since the effects due to it, are among the fundamental and most familiar of the science. The attractions and repulsions exhibited by it are identical in kind, though different in degree, with those exhibited between the two poles of the voltaic battery, and it is quite unnecessary to dwell longer on the point.

The heating power of common electricity, when passed through wires or other substances, is perfectly well known.

Until Faraday examined the subject, the magnetic power of ordinary electricity was by no means distinctly established, and the experiments of M. Colladon, of Geneva, on the point, were not received as decisive in consequence of their being accompanied by certain suspicious circumstances. The magnetic power of an electric current appearing to depend on *time* being allowed for its action, it was necessary to devise some means by which the almost instantaneous transmission of ordinary electricity should be checked, and the *intensity* of the charge reduced within manageable limits without the *quantity* being affected. To the retarding power of bad conductors, Faraday first looked, with the hope of producing this result, and combining this power, with the influence of a discharging train of enormous extent, being nothing less than the entire fabric of the metallic gas and water-pipes of the city of London, he succeeded perfectly in throwing the discharge of ordinary electricity into the form of a *current*, and then found, in full accordance with his expectations, that it possessed magnetic influence equal to that of a voltaic current of the same intensity. Deflections of the galvanometer were readily produced by discharging a Leyden jar through a wet thread about four feet long, connected with the discharging train, and these deflections were in the same directions that would have resulted from the transmission of a voltaic current under similar circumstances; *i. e.* the positively charged surface of the electric battery, coincided with the positive end of the voltaic apparatus, and the negative surface of the former with the negative end of the latter. Varying considerably the conditions of his experiments, Faraday found as the general result, " that a current of common electricity, whether transmitted through water or metal, or rarefied air, or by means of points in common air, is still able to deflect the needle; the only requisite being, apparently, to allow time for its action; that it is, in fact, just as magnetic in every respect as a voltaic current, and that in this character therefore, no distinction existed."

From the magnetic, transition is made to the chemical powers of ordinary electricity, and by a very ingenious and delicate series of experiments, the ability of the current to produce decomposition is very decisively and distinctly established. The decomposing power of electricity of the machine had been previously investigated by Dr. Wollaston, and although he furnished the strongest evidence in favour of this, his opinion was not received with confidence, because it was discovered that one of his leading experiments was erroneous. In this experiment, water was decomposed by passing a current of ordinary electricity through very fine wires, the points of which were guarded with glass coverings, so that only a mere section of the wires was exposed and immersed in the water; but it was observed, that from *each* pole or wire both oxygen and hydrogen were evolved; a violation of the well-established law of electric decomposition which proved, in the most decisive manner, that the effect observed was not due to its operation.

By employing paper moistened by various decomposable solutions, and connected with the electrical machine through the discharging train, Faraday obtained the amplest evidence of the chemical influence of the current. Sulphate of copper, iodide of potassium, sulphate of soda, &c. &c. were rapidly decomposed, so that no doubt could remain that voltaic and ordinary electricity had power of chemical decomposition alike in their nature, and governed by the same law of arrangement.

Atmospheric electricity being admitted universally to be of the same nature as ordinary electricity, instances of chemical decomposition by the former, furnish proofs of a like power belonging to the latter. Of these Faraday alludes to several, and especially to an experiment by Mr. Barry, in which two tubes, having wires passing through each closed end, as is common for voltaic decompositions, were employed. The tubes were filled with solution of sulphate of soda, coloured with syrup of violets, and connected by a portion of the same solution in the ordinary manner; the wire in one tube was connected by a *gilt thread* with the string of an insulated electrical kite, and the wire in the other tube by a similar *gilt thread* with the ground. Hydrogen soon appeared in the tube connected with the kite, and oxygen in the other, and in ten minutes the liquid in the first tube was green from the alkali evolved, and that in the other red, from the free acid produced. There are several doubtful points connected with this experiment, some of its details being with difficulty reconcilable with others; and Faraday remarks of it, "Mr. Barry's experiment is a very important one to repeat and verify. If confirmed, it will be, as far as I am aware, the first recorded case of true electro-chemical decomposition of water by common electricity, and it will supply a form of electrical current, which, both in quantity and intensity, is exactly intermediate with those of the common electrical machine and the voltaic pile."

With regard to magneto-electricity, the next form that comes under notice, the experimental effects obtained by it, conform fully to the standard. The attractions and repulsions due to a state of tension are readily exhibited; the evolution of heat has been distinctly indicated; magnetic effects led to the original discovery of this form of electricity; chemical decompositions have been effected by M. Pixii and M. Hatchette, after repeated failures on Faraday's part; physiological effects have been produced; and the feeble spark at first obtained has since been varied and strengthened by Nobili, Antinori, and others, so as to leave no doubt of its identity with the common electric spark.

At the period of the publication of the third series, in January 1833, certain experimental effects had not been produced with thermo-electricity, but prior to the publication of the collected researches in the volume now under review, these vacancies had been supplied, so that with the exception of the indications of tension, this form agrees fully with the others. "Only those effects are weak or deficient that depend upon a high degree of intensity: and if common electricity be reduced in that quality to a similar degree with the thermo-electricity, it can produce no effect beyond the latter."

The extraordinary physiological effects produced by the gymnotus and torpedo, are well known to depend on the power of evolving electricity, on contact, possessed by these singular animals; and relative to the identity of animal with other forms of electricity, Faraday remarks, "After an examination of the experiments of Walsk, Ingenhouz, Cavendish, Sir H. Davy, and Dr. Davy, no doubt remains on my mind as to the identity of the electricity of the torpedo with common and voltaic electricity: and I presume that so little will remain on the minds of others, as to justify my refraining from entering at length into the philosophical proofs of that identity. The doubts raised by Sir H. Davy have been removed by his brother, Dr. Davy: the results of the latter being the reverse of those of the former."

With the exception of tension, animal electricity exhibits all the experimental effects due to the influence of the other forms of electricity. Heat has been evolved, deflections of the needle produced, true chemical decomposition displayed, and the spark distinctly observed, by using the current derived from the gymnotus and torpedo. "In concluding this summary of the powers of torpedinal electricity," Faraday remarks, "I cannot refrain from pointing out the enormous absolute quantity of electricity which the animal must put in circulation at each effort. It is doubtful whether any common electrical machine has as yet been able to supply electricity sufficient in a reasonable time to cause true electro-chemical decomposition of water, yet the current from the torpedo has done it. The same high proportion is shewn by the magnetic effects. These circumstances indicate that the torpedo has power, (in the way probably that Cavendish describes) to continue the evolution for a sensible time, so that its successive discharges rather resemble those of a voltaic arrangement, intermitting in its action, than those of a Leyden apparatus, charged and discharged many times in succession. In reality, however, there is *no philosophical difference* between these two cases."

The general inference to be drawn from the collection of facts made by Faraday, is undoubtedly that *electricity, whatever may be its source, is identical in its nature.* The phenomena in the five kinds spoken of, differ in degree, not in character; and in that respect vary in proportion to the variable circumstances of *quantity and intensity,* which can at pleasure be made to change in almost any one of the kinds of electricity, as much as it does between one kind and another.

Before leaving this branch of the subject, Faraday gives a table, which, as furnishing in epitome, all the evidence for the entire identity of electricity, whencesoever derived, we shall transcribe here: premising, that the effects obtained at the original publication of the series under notice, are marked by an oblique, those obtained subsequently by a vertical cross.

Table of the experimental effects common to the Electricities derived from different sources.

	Physiological effects.	Magnetic deflection.	Magnets made.	Spark.	Heating power.	True chemical action.	Attraction & repulsion.	Discharge by hot air.
1. Voltaic electricity, ...	×	×	×	×	×	×	×	×
2. Common electricity, ...	×	×	×	×	×	×	×	×
3. Magnets electricity, ...	×	×	×	×	×	×	×	
4. Thermo electricity, ...	×	×	+	+	+	+		
5. Animal electricity, ...	×	×	×	+	+	×		

It thus appears that only five spaces remain unmarked, two under *attraction* and *repulsion*, and three under *discharge by hot air;* but although these effects have not yet been obtained, it is a necessary conclusion that they must be possible, since the *spark* corresponding to them has been observed. For when a discharge across *cold air* can occur, that intensity which is the only essential additional requisite for the other effects must be present.

Having fully satisfied his own mind as to the identity of electricities, Faraday next endeavoured to procure a common measure of the electricity excited by the machine and that derived from the voltaic pile, not only for the purpose of still farther confirming their identity, but also of demonstrating certain general principles, and creating an extension of the means of investigating and applying the chemical power of this wonderful and subtile agent.

His first object was to determine whether the same absolute quantity of ordinary electricity sent through a galvanometer under different circumstances, would cause the same deflection of the needle. A battery of eight jars was first employed, and was charged by thirty turns of a common machine, this charge was sent through a galvanometer to which an arbitrary scale, each division of which measured 4°, was attached, a thick wet string, about 10 inches in length, being included in the circuit. The needle was immediately deflected 5½ divisions.

Fifteen jars were next employed, and charged with precisely the same absolute quantity of electricity as in the first experiment, namely, that derived from thirty turns of the machine, and on discharge being made, as before, the needle was deflected to *precisely* the same point as in the former instance. The experiments were varied in different ways, and the current was materially altered in intensity, although continuing constant in quantity; yet it appeared that in all, the deflection of the needle was the same. Hence then the interesting general conclusion arrived at was, that *if the same absolute quantity of electricity pass through the galvanometer, whatever may be its intensity, the deflecting force upon the magnetic needle is the same.*

An effort was then made to establish a *ratio* between the quantity of electricity and the deflecting force, and although the experiment was not quite decisive, still, Faraday considered it highly probable, that *the deflecting force of an electric current is directly proportional to the absolute quantity of electricity passed,* at whatever intensity that current may be. The same inference is supported by an experiment of Drs. Ritchie and Harris, which has proved the same law to obtain in the case of the *heating powers* of an electric current.

The next point was to obtain a *voltaic* arrangement producing an effect exactly equal to that just alluded to, and it was found, after several preliminary arrangements, that a zinc and a platinum wire, each an eighteenth of an inch in diameter, fixed in a support five-sixteenths of an inch apart, and immersed in a solution consisting of one drop of strong sulphuric acid in four ounces of distilled water, and retained in it during eight beats of a watch that gave one hundred and fifty in a minute, produced a deflection of exactly $5\frac{1}{2}$ divisions of the scale. Hence then it appeared that a voltaic circuit, consisting of these two small wires was capable of producing in $\frac{8}{150}$th of a minute a current of electricity equal in deflecting power to that derived from thirty turns of the large machines; and by extending the experiments to chemical power also, the same standard arrangement was found equivalent to the same number of revolutions of the machine. Hence it follows, that *the chemical powers, as well as the magnetic force, is in direct proportion to the absolute quantity of electricity which passes.*

The third series terminates here, and we scarcely know which to admire most, the thorough theoretical knowledge of the subject displayed, or the inexhaustible experimental resources, as delicate and beautiful as they are effective, exhibited by Faraday throughout its whole progress. The question of the identity of electricities was in a state of uncertainty, analogous to that of several other questions in physical science, which require the hand of a master to resolve them, and in no instance, in the past history of science, has greater skill or perseverance ever been brought to bear upon such problems, than in that which has now been under consideration. Both in the present and in the succeeding series, there are indications, feeble however and imperfectly developed, of the great principles which were opening on Faraday's mind, and on which he dwells at length in the fifth series of the researches. We seem now to be like travellers drawing gradually nearer and nearer to regions whither silver and gold and precious stones incite our approach, and we are encouraged to proceed by discerning occasionally among the comparatively inferior materials that bestrew our paths, the sparkle of the rich ore that ere long will so abundantly reward our efforts. One path more must be traversed before we reach the grand object of Faraday's labours, but happily we shall find much that is novel in it, to excite our curiosity, all that is beautiful in inductive research to gratify our reasoning faculties, abundant materials for thought, and to those who love it, for speculation also.

The fourth series of the experimental researches is occupied with the development of a new law of electric conduction, and with considerations on conducting power in general. " It was during the progress," says Faraday, " of investigations relating to electro-chemical decomposition which I still have to submit to the Royal Society, that I encountered effects due to a very *general law* of electric conduction not hitherto recognised: and though they prevented me from obtaining the conduction I sought for, they afforded abundant compensation for the momentary disappointment, by the new and important interest which they gave to an extensive part of electrical science."

The first indications of this new law, were obtained by Faraday while working with ice and the solids resulting from the freezing of solutions, and he found that the interposition of the slightest possible film of such solid matter between the conducting portions of a voltaic arrangement wholly interrupted the power of conduction, however well the same body might conduct in its fluid state.

By an ingenious arrangement of platinum plates in small tin vessels filled with water, which was subsequently frozen by a mixture of salt and snow, a thin plate of solid ice was made to intervene between the tin and the platinum. By connecting the tin and platinum respectively with the opposite poles of a voltaic battery, a strong current of electricity was directed through them, but on reaching the barrier of ice, it was so effectually checked, that a galvanometer introduced within the circuit, was not in the slightest degree deflected. The moment, however, that liquefaction took place, power of conduction followed, and this power was invariably accompanied by decomposition of the water.

As it seemed very improbable that this *law* of the assumption of conducting power during liquefaction and loss of it during congelation would be peculiar to water, Faraday, with characteristic earnestness and deep perception of the relations of the law indicated, immediately experimented on various other bodies of different chemical characters, and obtained the most decisive evidence of its general applicability, and of its right to be considered a true *law of the phenomena,* the first requisite towards a philosophical investigation of the *cause* to which it was due. The various substances experimented upon were,

First. *Water.*

Amongst *Oxides.* Potassa, protoxide of lead, glass of antimony, protoxide of antimony, oxide of bismuth, *chlorides* of potassium, sodium, barium, strontium, calcium, magnesium, manganese, zinc, copper (proto) lead, tin, (proto) antimony, silver.

Iodides of potassium, zinc, and lead; protoxide of tin; periodide of mercury; *fluoride* of potassium; *cyanide* of potassium; sulpho-cyanide of potassium.

Salts. Chlorate of potassa; nitrates of potassa, soda, baryta, strontia, lead, copper, and silver; sulphates of soda and lead; proto-sulphate of mercury; phosphates of potassa, soda, lead, copper, phosphoric glass, or acid phosphate of lime; carbonates of potassa and soda, mingled and separate: borax, borate of lead, per-borate of tin; chromate of potassa, bi-chromate of potassa, chromate of lead; acetate of potassa.

Sulphurets. Sulphuret of antimony, sulphuret of potassium, made by reducing sulphate of potassa by hydrogen; ordinary sulphuret of potassa.

Silicated potassa: chameleon mineral.

That this list might be enormously extended, Faraday has no doubt; but he had not time to do more than confirm the law by a sufficient number of instances.

Some anomalies occurred, but these, it was anticipated, would disappear under more careful experiments, and in a later series the point is successfully resumed. The conducting power gained by the bodies experimented upon was very great, water being the feeblest of all, and the *oxides chlorides, &c.*, exhibiting it some hundred times higher than water.

"This *general assumption of conducting power*," Faraday remarks, "by bodies as soon as they pass from the solid to the liquid state, offers a new and extraordinary character, the existence of which, as far as I know, has not before been suspected; and it seems importantly connected with some properties and relations of the particles of matter, which I may now briefly point out. In almost all the instances," he continues, "as yet observed, which are governed by this law, the substances experimented with have been those which were not only compound bodies, but such as contain elements known to arrange themselves at the opposite poles; and were also such as could be *decomposed* by the electrical current. When conduction took place, decomposition occurred; when decomposition ceased, conduction ceased also; and it becomes a fair and an important question, whether conduction itself may not, wherever the law holds good, be a consequence, not merely of the capability, but of the act of decomposition? And that question may be accompanied by another, namely, whether solidification does not prevent conduction, merely by chaining the particles to their places, under the influence of aggregation, and preventing their final separation in the manner necessary for decomposition?" These two questions contain the genus of that electro-chemical theory which is developed in detail in a subsequent series; and several anomalies are adverted to by Faraday, which he did not remove until a future period. It is interesting, however, to remark the dawning of those comprehensive views which have wrought an entire revolution in chemical science, and to observe how their first beginnings were derived from the happy and determined working out of an incidental observation, whose importance would in all probability have escaped a mind less acute than that of Faraday. Such a contemplation of "the day of small things" in science, affords at once a lesson to instruct, and an example to encourage us: it tells us of the importance of tracing any unusual result into all its various relations and connections; and it brightens our hopes, by shewing us, how great may be the consequences of assiduously and perseveringly pursuing this principle, in our researches, whatever the nature or field of these may be.

The law we have been adverting to, exhibits a singular relation between the power of conducting electricity and that of conducting heat, and seems to imply a natural dependence between the two. "As the solid becomes a fluid, it loses almost entirely the power of conduction for heat, but gains in a high degree that for electricity; but as it reverts back to the solid state, it gains the power of conducting heat, and loses that of conducting electricity. If therefore the properties are not incompatible, still they are most strongly contrasted; one being lost, as the other is gained. We may hope, perhaps, hereafter, to understand the physical reason of this very extraordinary relation of the two conducting powers, both of which appear to be directly connected with the corpuscular condition of the substances concerned."

Were we disposed to indulge in speculation, we might dwell at some length on the interesting relation these views have to certain points of geological science, those, namely, connected with the occurrence of crystallised minerals in metamorphic and igneous rocks. That the occurrence of simple minerals in rocks that have been subjected to the action of heat, is intimately related to, or perhaps dependent upon, the action of polar electrical forces, we entertain the firmest conviction, although we still require experimental evidence to complete the chain of induction in favour of this idea, which receives some confirmation from the appearance of several natural mineral bodies in the list Faraday gives of those he has found to be subject to the new law of conduction he has established. It would occupy, however, too much of our space and time to enter in any detail on this point at present, and as without such detail it would be vain to attempt to do justice to it, we prefer passing it by without farther remark.

The fourth series is concluded by some general remarks on conduction; and it will suffice for us now to give the summary of the conditions of electric conduction in bodies, with which Faraday terminates his paper.

"All bodies conduct electricity in the same manner, from metals to lac and gases, but in very different degrees.

"Conducting power is in some bodies powerfully increased by heat, and in others diminished; yet without our perceiving any accompanying essential electrical difference either in the bodies, or in the changes occasioned by the electricity conducted.

"A numerous class of bodies, insulating electricity of low tension, when solid, conduct it very freely when fluid, and are then decomposed by it.

"But there are many fluid bodies which do not sensibly conduct electricity of this low intensity; there are some which conduct it, and are not decomposed; nor is fluidity essential to decomposition.

"There is but one body yet discovered (per-iodide of mercury) which, insulating a voltaic current when solid, and conducting it when fluid, is not decomposed in the latter case.

"There is no strict electrical distinction of conduction which can, as yet, be drawn between bodies supposed to be elementary, and those known to be compounds."

We have now approached the point to which these preliminary researches were subservient, and our next article will be devoted to the development of Faraday's electro-chemical theory—a theory not more remarkable for its comprehensiveness, than for its entire consistency of detail, and not more happy in its explanation of established phenomena, than successful in its predictions of the results of combinations formed in accordance with its principles.

May 14*th*, 1842.

Remarks on a few Plants from Central India.—By W. GRIFFITH. ESQ., F.L.S., *Imp. Acad. Nat. Cur.*

The accompanying is a partial account of a few plants, kindly presented to me by my friend, Mr. D. Macleod, Principal Assistant to the Commissioner, Jubbulpore. Although their number is very limited, yet as they come from the "terra incognita" of Central India, and as one undescribed genus is, I think, found among them, I am in hopes that the account may not be altogether devoid of interest, more particularly as the notes appended to the specimens by Mr. Macleod, are practical and interesting.

1.—CURCUMA. Natural family, *Scitamineæ,* the specimen is without leaves; its native name is Bun-huldee.

2.—CEDRELA. Natural family, *Cedrelaceæ,* so closely resembling C. Toona, the Toon of India, that I am unwilling to attempt to characterise it as distinct: although Mr. Macleod says, "this is a tree which I have only met with in a single small Pergunnah, and there in abundance; it is called by the natives here the Mâha-Nîm. It closely resembles the Toon, yet I believe it is not the same. Its wood is of a pinkish red, but different in tinge from that of the Toon."

3.—Bauhinia Racemosa. Roxburgh's Fl. Indica, ii. p. 325. B. Vahlii, Wight, and Arnott's Prodromus: Fl. Peninsulæ Orientalis i. p. 297, Natural family, *Leguminosæ.* The specimens have been gathered without tendrils.

" The Mahol or Mohlain; a gigantic creeper, of which the bark is extensively used for making twine and rope, being very strong, and withstanding the seasons much better than Sun or Bakkal. Is this the same as that recently sent to the Agricultural and Horticultural Society from the hills, through the Government, for experiment and report."—*(Mr. Macleod.)*

The plant is widely diffused, occurring in all the hilly parts of the N. W. and N. E. Frontiers, in profusion on the Suvalik Hills. Mr. Royle mentions its being used for the manufacture of rope, and Dr. Roxburgh notices its being applied to line baskets, and the various packages in use among the hill people.

4. 5. 6.—Three species of Natural family, *Umbelliferæ.* The Tej-raj, Bhoj-raj, Bal-raj, of the natives.

Mr. Macleod informs me, that the first " grows in great abundance on the Basaltic hills and high lands. There are said to be seven different kinds of herbs, commonly called the " seven Rajes," (Sât-râj, Hindee), of which the roots are largely used internally by the natives for restoring strength to a debilitated constitution ; of these the most spoken of are, Bhoj-raj, Tej-raj, and Bal-raj."

Having no knowledge of the very intricate family to which these plants belong, their determination requiring an European Herbarium, and the specimens being without ripe seeds, I do not attempt to name them. Assuming that the other four " Rajes" are equally correctly grouped, we shall have at least seven umbelliferous plants indigenous to Central India ; a large proportion, and one indicating considerable elevation.

6. This plant belongs to the Natural family, *Verbenaceæ;* it is interesting for being allied to the teak, and to which affinity it owes its valuable properties as a timber tree. It appears to me unknown to science.

HEMIGYMNIA.* *Calyx* infundibuliformis, striatus, 5-dentatus. *Corollæ* tubus infundibuliformis ; laciniæ 5 (angustæ, tubo duplo longiores.) *Stamina* 5 aqualia, inclusa. *Ovarium,* 4-loculare, 4 ovulatum: ovula solitaria, ascendentia. *Stylus* bifidus, rami profunde bipartiti, intus stigmatosi. *Fructus* (immaturus) drupaceus, rostrato-cuspidatus, calyce cupuliformi semicinctus.

Arbor *mediocris ;* partibus novellis pube ramosa tomentosis. Folia *opposita, cordata, vel cordato-rotundata.* Inflorescentia *terminalis, cymoso-corymbosa.* Flores *congesti, in apicibus pedicellorum brevium articulati, mediocres, albi?*

Habitus quodammodo Rottleræ, aspectus florum Lythraricus, Pemphidis si velis.

Hemigymnia Macleodii.†

Habitat: Sylvæ Jubbulpore vicinæ, plerumque cum Tectona consociata.

Mr. Macleod remarks of this tree, that it is called by the natives Dahman or Dahyan, and is abundant in our jungles ; it is not to be found at a less distance than from thirty to forty miles from Jubbulpore ; it is almost always, if not in every case, in association with the teak, but in less quantity than that tree. It grows to a considerable size, and has a thick stem, not quite so tall as that of the teak, but of greater proportional compass. The wood is remarkable for its

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* In allusion to its half-naked fruit, in contradistinction to that of Tectona.

† I have named this after its discoverer, one of the ornaments of the distinguished service to which he belongs.

great strength and elasticity; its properties appear to resemble those of the lance wood."

In answer to my enquiries, whether the timber might be introduced to some of the great marts of India, Mr. Macleod states: "Both this and the teak are found on the banks of the Nerbudda, and are floated down to Jubbulpore as late as the month of December; from hence I apprehend they might be floated in the rains, (unless the falls at Bhera Ghat should be an insuperable obstacle,) to the sea. The wood from above Mandla, however, cannot thus reach us, as near that place there are falls which form an insuperable barrier at all periods. As far as I can judge, I should doubt whether the wood, either of this or of the teak, are either in size or quantity, sufficient to render them available for general export from this remote locality."

This genus appears to me more nearly allied to Tectona than to any other of the same natural family: it differs, however, abundantly from that genus in its calyx and corolla, the not exserted stamina, the division of the styles, and half-naked fruit like those of Tectona; its leaves are rough from siliceous (?) deposits. The other regular-flowered verbenaceous Indian genera, with which it may be necessary to contrast it, are *Sphenodesme*, *Symphorema*, *Callicarpa*, *Hymenopyramis*, and perhaps *Glossocarya*.

The two first, with *Congea*, are at once known by their remarkable involucrate inflorescence. *Callicarpa* is distinguished by the quaternary number of parts of the calyx and corolla, by the exserted stamina, and berried, highly coloured or white fruits. *Hymenopyramis* by the same characteristics affecting the calyx, corolla, and stamina; by its bilocular ovarium, and by its capsular, 4-valved fruit, enclosed in an enlarged scarious four-winged or angled calyx. *Glossocarya*, which varies with quaternary parts, will be known by its one-celled ovarium, and its peculiar placentation; and by the very remarkable capsular fruit, which separates into 4 valves, with the upper-half of each of which, a fourth part of the upper-half of the placenta separates.

Hemigymnia in the remarkable character of divided simple styles adds, it appears to me, to those indications of affinity with Cordia, furnished by Tectona.

As neither Hymenopyramis, nor Glossocarya, have been yet, so far as I know, described; but on the contrary are placed " ad calcem familiæ" in Dr. Lindley's Introduction to the Natural Orders, I subjoin characters of both.*

HYMENOPYRAMIS, Wall. *Calyx* 4-dentalus. *Corolla* subinfundibuliformis, subregularis, 4-partita. *Stamina* 4 exserta. *Ovarium* biloculare; ovula cujusgue loculi, 2. pendula, *Stylus* exsertus. *Stygma* bifidum. *Capsula* calyce ampliato 4-gono, 4-alato inclusa, dicresile 4-valvis; placenta libera, bipartibilis. *Semina* pendula, (exalbuminosa.)

Frutex *subscandens*, ramis *elongatis,* ramulis *fructigeris brachiatis.* Folia *opposita, ovato-lanceolata subintegra, subtus tomento brevi albida.* Cymæ *axillares et terminales.* Flores *subumbellati, congesti, albi, parvi.* Ovarium *glabrius-aitum, apice glandulosum.* Pedicelli *fructuum elongati, capillucei.* Capsula *pilosa, glandulis sessilibus luteis fragrantibus inpersa.*

Hymenopyramis brachiata, *Wall. Catal.* No. 774.

I have seen this plant in the Serampore Botanical garden, but the above description is taken from dried specimens communicated by Dr. Wallich.

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* This leads me to remark, that it is curious that genera referred to their places by Dr. Wallich *without* doubt, should be viewed *with* such doubt as to be registered " ad calcem familiæ." Anneslæa, an undoubted Ternstræmiacious Plant, is even placed " ad calcem regni." I might extend the remark to some of Jack's Plants, such as Eurycoma, which he referred to Connaraceæ with strict propriety, as it appears to me. Both these Botanists deserve to have more confidence placed in their determinations, more particularly Jack, who appears to be a master of description, and of very correct views of affinities.

The genus appears to me to partake of the characters of Callicarpa, and to a certain extent of those of Tectona.

GLOSSOCARYA, *Wall.* *Calyx* infundibellíformis, 4-5 dentalus. *Corolla* subhypocrateriformis (tubò cylindraceo gracili,) 4-5 partita, laciniis subæqualibus. *Stamina* 4-5, exserta- *Ovarium* 1,—loculare (!) placentæ bilamellatæ, lamellis recur. vato-incurvatis; ovula 4, pendulo-appensa. *Stylus* filiformis, exsertus. *Stigma* bifidum. *Capsula* (semi-exserta) 4-valvis; valva quæque cum placentæ parte supera seminifera secedens. *Placentæ* pars inferior, libera, persistens. *Semina.*

Frutex *cano-pubescens.* Folia *cordato-ovata.* Flores *parvi, in corymbis terminalibus congesti.* Corymbi *fructus magis expansi.* Capsulæ *pilosæ, ascendentes, secundæ.* Valvæ *semina basialata simulantes.*

Glossocarya mollis, *Wall. Catal.* No. 1741.

Hab. Rupes calcareæ ad speluncas Demithawt editas fluminis attran, provinciæ Molmain, regni Burmanni, (No. 305, of a small Molmain collection, sent home several years ago.)

The ovarium, unless I have mistaken its structure, is one-celled from want of cohesion between the placentæ, which do meet in the axis. The placentation is much like that of some Cyrtandreæ, it is, however only to be considered as the maximum amount of a placentation of common occurrence in Verbenaceæ.

The separation of the fourth part of the upper-half of the placenta, (in which the abortive ovula are to be found,) with each valve of the capsule appears to me remarkable, especially when taken into consideration with the integrity of the lower part of the same organ. It is, perhaps, a curious way of adhering to the nucamentaceous dehiscence, characteristic of many genera of the family.

The above descriptions are only to be considered as temporary; they are only given to assist such Indian botanists as have had no access to the plants, which they are intended to characterise.

There are few Indian families in greater need of revision than Verbenaceæ, the characters of which require to be much enlarged. Even in so late a work as the Scrophularineæ Indicæ of Mr. Bentham, the incomplete characters of a fruit, which is indehiscent and an ovarium divided into uniovulate cells, are given as affording " more decided" marks of distinction from Scrophularineæ. For the present, I have only to remark that Selagineæ are not absolutely distinguished from Verbenaceæ by their unilocular anthers; such a structure, (even were it sufficient for the foundation of a distinct family,) appearing to exist in some Verbenaceæ, allied to Clerodendrum; which genus may perhaps be considered as the type of the family.

And as connected with Indian Verbenaceæ, I may add that Corysanthera, referred to that family with doubt by Dr. Wallich, belongs to that section of Gesnereæ, described by Jack as a distinct family under the name Cyrtandraceæ.*

The last specimen I have to notice, is a fragment of a Ceropegia, of the natural family *Asclepiadeæ*. Of this Mr. Macleod, says, " The Bagaia Kanda is a tuber exceedingly resembling the Blatœ, which I consequently imagine may be perhaps rendered by culture a valuable addition to our esculent vegetables, especially as it appears to come to maturity in May. I have accordingly transferred a few plants of it to my own garden for experiment. The basaltic, however, is it native soil, and I find it sickens in the light siliceous soil, which composes our gardens here."

As Mr. Macleod has in the most obliging manner promised to communicate to me a more general collection, I hope before long to send you further notices regarding the vegetation of Mr. Macleod's district. From all that I could learn during a short visit to Jubbulpore, it would appear to include table lands, 5 or 6,000 feet above the level of the sea, and possessing a very moist climate.

Malacca, June 10, 1842.

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* Lin. Trans. vol. xiv. p. 23.

Experiments on the Magnetic Influence of Solar Light. By Lieut. R. Baird Smith, *Bengal Engineers.*

[Continued from p. 264, vol. iii.]

Section III.—*On the Magnetic Influence of Solar Light, transmitted through different coloured Media.**

The only experiments on this branch of the subject of Solar Magnetism with which I am acquainted, are those due to Mrs. Somerville; but as far as I have, up to the present time, been able to ascertain, only two coloured Media, namely green and blue, were employed by her, and both with success. Needles exposed to the sun for three or four hours, under a glass coloured blue by *cobalt*, were found to have had imparted to them a feeble, but none-permanent, magnetism; and in subsequent experiments, by extending the period of exposure to six hours, a very distinct degree of Magnetism was acquired and permanently retained. Green glass was also tried, and was found to admit of the passage of magnetic rays; and needles suspended behind a window pane, half covered with blue and green riband, were found to have been equally strongly magnetised as when coloured glass itself was employed.

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* It will furnish to European observers, a striking illustration of the paucity of experimental resources in the remoter parts of British India, when I state that up to the present time, although aided by the kind and active efforts of friends, I have found it quite impossible to procure, on any conditions, a *common glass prism,* to enable me to complete the experiments of the second section. It is probable I shall be obliged to procure such a piece of apparatus from England, and in the mean time I cannot but fear that the opportunity of completing this section for at least a very long period, will be allowed to pass. The completeness of the enquiry is of course interfered with by the absence of the second section; but the first and third, are, at the same time, perfect in themselves, and in no way dependant on its presence, so that it is of comparatively little moment, in what order they are published. It is impossible however to rest satisfied with the present imperfect condition of what I meant to be a perfect examina-

The earlier experiments under this section, were the first of the entire series, and the method of observation employed by me throughout them, was the same I believe as that of Mrs. Somerville. This remark is however made with some reservation, in consequence of my having been unable to procure any detailed account of this lady's experiments, but there is still sufficient in the brief and imperfect notices I have had the opportunity of examining, to make me feel tolerably certain on the point. Half of each experimental needle employed was covered with several folds of thin (quarter-tola) paper, and then exposed on a proper support to the influence of the sun's light transmitted through the medium employed. After exposure, the needle was removed to a room, and being there delicately suspended, a small compass needle was carefully and gradually approximated to it, and the nature of the action between the two observed. To this mode of observation there are, in my opinion, insuperable objections, but as these developed themselves only in consequence of the experiments to be detailed, I shall reserve all remarks upon this point until these details have been given, since the reality of my objections will then be much more readily felt and admitted.

tion of the question of solar magnetism, and I will return to the subject on the earliest opportunity. In ignorance of what may occur in the interval, I will not however detain the third section by me, until such an opportunity presents itself, lest I should be disappointed altogether.—R. B. S.

Aug. 4th, 1842.—Since the above note was written I have had the pleasure, through the active kindness of my friend Mr. M'Clelland, of receiving all the apparatus necessary for the composition of the second series of these experiments. To the characteristic liberality of J. W. Grant, Esq. C. S. (in this instance, the more grateful as shewn towards a total stranger), I have been indebted for an excellent prism, well adapted to my objects. The acceptable gift reached me however, only the day before the rainy season regularly set in, and I have of course been unable to bring it into use as yet. Unless circumstances should interfere, the second section will be undertaken at the commencement of the cold weather.

Expt. I.—*Camp, Berheri, Doab Canal, November 20th* 1841.

Experimental needle *A*, having a length of 1.625 inches and a diameter 0,031, " with brightly polished surface and having no previous magnetism, was exposed upon a sun-dial to the light of the sun passed through a *dark green glass*, from 10 A. M. to 12, and on being submitted to the action of the testing needle, the following results were observed.

1. On approximating the *north pole* of the testing needle to the extremity of the *exposed part* of needle *A*, the latter was strongly *attracted.*

2. On repeating this process with the extremity of the *covered part* of *A*, equally strong *repulsion* was manifested.

3. On approaching the *south pole* of the testing needle to the extremity of the *exposed part of A, repulsion,* equal to the attraction exhibited in the first observation, was displayed.

4. On repeating the approximation to the *covered part* a corresponding *attraction* was observed.

Whence it clearly appears that the experimental needle *A* had become perceptibly magnetic, its exposed end having acquired southern, its covered end northern Polarity ; the enquiry immediately arises, was this effect clearly and distinctly due to the action of solar light ? I shall therefore now state the circumstances that appear to me both to render this more than doubtful, and to indicate *one* of the sources of error to which the method of observation employed, is exposed. The needle *A*, while subjected to the action of the sun's light, was fixed by means of a slender wooden support in the place of the magnetic meridian, forming an angle with the horizon of between 40° and 50°. It was therefore in a most favourable position for being magnetised by the inductive action of the earth ; supposing it had been so, in how far, it may be enquired, do the indications of Polarity actually obtained correspond with those that theoretically would result from such action.

To this I reply they are *identical*, for as the exposed extremity of needle *A* during the period of action pointed to the south pole of the earth, the force of induction would tend to generate in that extremity a northern Polarity, and such Polarity *really* exists in it, although in a former paragraph I stated it had become a south pole. The form of expression to which allusion was made in the first section of these experiments, immediately explains this apparent anomaly, since it was then stated that while, by sanction of custom, the extremities of a magnetic needle that point to the north and south poles of the earth, are called respectively the north and south poles of the magnet, the nature of the Polarities resident in them is precisely the converse of that indicated by the terms employed. Now it has often been experimentally proved that the inductive action of the earth's magnetism will act upon very small masses of steel or iron, changing the one permanently, the other temporarily into magnets, and hence I conclude that experiments on the subject of Solar magnetism, from which reference to it has been excluded, are seriously deteriorated, if not rendered wholly valueless. That such a cause may have interfered with Mrs. Somerville's results I cannot doubt, when I find the needles in her experiments were *suspended vertically*, thus being only about 20° removed from the line of dip, which in the latitude of London is about 70°. In farther confirmation of this view, I may mention that Faraday has repeatedly employed the vertical as a sufficiently close approximation to the actual dip, throughout the course of his beautiful experiments on Terrestrial magneto-electric induction, and has exhibited perfectly decisive and satisfactory results with it, and apparatus of a very minute character.

***Exp.* II.** Experimental needle *B*, having a length of 1.5 " and a diameter of 0.016," prepared similarly to the preceding, was exposed under a dark green glass from $\frac{3}{4}$ P. M. to 1$\frac{3}{4}$ P. M. and on being tested exhibited the following results. I may however premise that the needle was partially oxidated on its exposed half.

1. On approximating the *north pole* of the testing needle to the *exposed extremity* of *B* strong *repulsion* ensued.

2. On repeating this with the *covered extremity*, *repulsion* also was observed.

3. On bringing the pole as above, to the *centre* of the needle *B*, *attraction* was immediately indicated.

4. A repetition of these observations with the *south pole* of the testing needle, confirmed the distribution of Polarity exhibited by them.

From which it appears that northern Polarity had been imparted to the two extremities of *B*, southern Polarity accumulated in the *centre*. This peculiarity was in all probability the result of the partial oxidation of the surface of the experimental needle, as such a state has been already shewn to produce like effects.

I may now point out a source of interference with these results, that prevents our attributing them to the magnetic action of solar light. Since every magnet has a tendency to act by induction on any matter in its vicinity capable of being magnetised, it is very evident that the approximation of the testing needle must produce a change in the magnetic condition of the needle under experiment. It is therefore impossible to say, how much of the effect observed is due to this cause, how much to any other that may be capable of producing similar effects; and the uncertainty thus introduced must ever prove an obstacle to the formation of decided conclusions. The actions themselves were farther observed to be so feeble, that to attempt to allot them to different causes would be vain and unsatisfactory effort.

There is yet another source of error to which I may allude, namely, that which arises from the possibility of minute electric currents being excited in the mass of the needle under experiment, in consequence of one half of it being covered with a non-conducting material, the other freely exposed to the heat of the sun; it is well known that such differences do give rise to thermo-electric currents, and these have been rendered perceptible under such circumstances as to make it far from improbable that in experiments like the present, their influence may have been felt. It has been found that even with small pieces of common clay, unequally moistened and exposed to the heat of the sun, electric currents have set in directions from the hotter to the colder portions, and the mutual re-action of electricity in motion and magnetic forces, is too well known as the source of some of the most interesting and important phenomena in the entire range of science, to require to be more that merely adverted to.

These different considerations on the causes that may interfere with the results of observations made after the preceding method, have so completely destroyed my confidence in it, that I consider it unnecessary to detail the remaining experiments, in which it had been employed. I may however state that their results were uncertain and capricious, occasionally tending to prove, and occasionally to disprove, the theory of the magnetic influence of light.

In the subsequent tables of experiments, the same method by oscillations has been employed as in the preceding sections, and as the sources of error are almost wholly eliminated by it, the indications afforded are decisive and satisfactory. The influence of unequal temperature in the portions of the cylinders exposed to the sun's action still operates, and perhaps to this source may be attributed the very minute indications of variation of intensity some of the tables exhibit. As this however never amounts to more than a single second, and is exhibited in but few instances, the inference is undecisive, and the observed difference may be owing merely to some trifling alteration in the conditions of experiment, or to a minute error of observation.

1. Experiments on the magnetic influence of light, transmitted through coloured glass media.

The pieces of steel employed in these experiments were all of the same length, namely, two inches, and of diameters between 0.05 and 0.04 inches. They were placed upon a table, one half being under the glass which was slightly inclined so that the sun might strike directly upon it, and the other half freely exposed to the white light of the sun without any paper covering. It having been previously shewn that undecomposed light could produce no magnetic effects, the free exposure of one-half of each cylinder to it, could not in any way vitiate the results due to the action of the light passing through the coloured medium, and every precaution was observed to guard against other interfering causes.

I now proceed to give details of the experiments under the present section.

Tables of Experiments.

TABLE I.

Shewing Duration Oscillations of Testing Needle, with Cylinder A in front, before and after exposure.

MEDIUM GREEN GLASS A.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						
1	28th	10	2	2	0.05	60°	96°	10	95	95	
2	...	...	...	...	...	...	...	10	95	96	
3	...	...	...	...	...	...	...	10	95	95	
4	...	...	...	...	...	...	...	10	94	95	
5	...	...	...	...	...	...	...	10	95	95	
							Sums, ...	50	474	476	
							Means, ...	10	94.8	95.2	

Whence it appears that there was an increase in the duration of ten oscillations of 0.4 of a second, a result so trifling, that it may with confidence be inferred that no change whatever took place in the magnetic condition of the cylinder A, in consequence of its exposure for four hours to the light of the sun, which was most favourable for the experiment, the day being fine and clear, and the sky perfectly cloudless. And it now appears clear, as will be still farther confirmed, that the results obtained by the method of approximation previously employed were erroneous, or at least due to other causes than any power of imparting magnetism resident in the Solar Rays. Although *theoretically*, the currents caused by the irregularity of temperature throughout the cylinder, may influence the vibrations of the testing needle, it does not appear from this table, that *practically* it does so, to any appreciable extent. It is just possible, and nothing more, that the minute retardation observed may be an effect of this cause, and since the covered and exposed portions of the cylinder were placed indifferently before the testing needle, the effect would occasionally, as in the present instance, tend to retard, and occasionally to accelerate the oscillations of the needle.

TABLE II.

Shewing Duration of Oscillations of Testing Needle with Cylinder B in front, before and after exposure.

MEDIUM GREEN GLASS B.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillation.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						Sun very bright
1	28th	11¼	3¼	2	0·04	73°	91°	10	96	96	and powerful,
2	...	...	...	...	...	...	...	10	96	96	Sky cloudless.
3	...	...	...	...	...	...	...	10	95	96	
4	...	...	...	...	...	...	...	10	96	96	
5	...	...	...	...	...	...	...	10	95	96	
						Sums,	...	50	478	480	
						Means,	...	10	956	96	

This Table it will be observed, gives precisely the same difference of 0.4 " as the last, and hence furnishes no support to the Magnetic Theory.

TABLE III.

Shewing Duration of Oscillations of Testing Needle with Cylinder C in front, before and after exposure.

MEDIUM-LIGHT RED GLASS C.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						
1	18th	10½	2½	2	0·05	62°	92°	10	89	87	
2	...	...	...	...	...	...	...	10	88	87	
3	...	...	...	...	...	...	...	10	88	87	
4	...	...	...	...	...	...	...	10	88	87	
5	...	...	...	...	...	...	...	10	88	87	
							Sums, ...	50	44·1	435	
							Means. ...	10	88·5	87	

The difference of 1.5 " exhibited in the preceding experiments arises, I have no doubt, from mere error of observation, or as remarked before, possibly from the unequally exposed portions of the cylinder affecting the testing needle. No indications, however, of magnetic polarity could by any means be obtained with the cylinder, and I therefore infer no such polarity existed it."

TABLE IV.

Shewing Duration of Oscillations of Testing Needle with Cylinder D in front, Before and after exposure.

MEDIUM DARK RED GLASS.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						A high wind prevailed at first. Exposure delayed till wind lulled.
1	28th	10¾	2¾	2	0·05	68°	92°	10	97	96	
2	...	...	...	...	...	...	...	10	97	96	
3	...	...	...	...	...	...	...	10	96	96	
4	...	...	...	...	...	...	...	10	97	96	
5	...	...	...	...	...	...	...	10	97	96	
						Sums	...	50	484	480	
						Means	...	10	96·8	96	

During the course of the forenoon on which this and the succeeding series of experiments were made a high wind prevailed, from the influence of which upon the needle, a difference of 6′ or 7′ in the periods of Oscillation before and after exposure, was observed. As I had taken every possible precaution to guard against the interference of currents of air, I at first thought I had obtained decisive indications of magnetic action, and under this impression proceeded to verify the results by means of the unmagnetic testing apparatus. I was therefore somewhat disappointed, when I could obtain no indications whatever of polarity by its means, as I knew it was capable of shewing the presence of much inferior magnetic intensity to that indicated by the above mentioned difference. The experiments were accordingly repeated after the wind had completely lulled, and the result very clearly proves that in the first instance, a disturbing cause had interfered, which no doubt was the wind.

TABLE V.

Shewing Duration of Oscillations of Testing Needle, with Cylinder E in front, before and after exposure.

MEDIUM VERY DARK RED GLASS.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						Wind high at first. Exposure, repeated after wind lulled.
1	28th	11	3	2	0·05	72°	91°	10	97	97	
2	...	...	...	...	...	...	...	10	96	97	
3	...	...	...	...	...	...	...	10	97	97	
4	...	...	...	...	...	...	...	10	97	97	
5	...	...	...	...	...	...	...	10	97	97	
						Sums ...		50	484	485	
						Means ...		10	96·8	97	

From the preceding experiments it may with safety be concluded, that no magnetic influence whatever is exerted by light, transmitted through coloured glass media; and as in former instances, it may be inferred that the results obtained by Mrs. Somerville were in reality due to the action of some unrecognised cause, capable of producing magnetic phenomena. Even supposing, in the present instance, decisive indications of such phenomena had been obtained, it would still have been fairly a question whether they were due to the decomposed light, for it must be recollected that *metallic oxides* are the chief materials employed in imparting colours to glass and some of these oxides, as of iron and cobalt, belong themselves to the class of independent magnetic bodies. It is more than probable that the red colour of the glass employed in these experiments was imparted by means of oxide of iron in a very large proportion, mixed with a minute quantity of copper, so that had there been evidence of increase of magnetic intensity in the cylinder, it would have been necessary to take the presence of the former substance into consideration, and to determine clearly the influence it had produced, ere any decisive inference as to the real source of the magnetism, could have been ventured on. In this point of view, one of Mrs. Somerville's experiments is peculiarly objectionable, and cannot possibly, I think, be received as any proof of the magnetic action of light. The instance alluded to, is that wherein it is stated that the light was transmitted through a glass coloured blue by *cobalt*, a body which we well know, possesses the most distinct and decisive independent magnetic properties, and which therefore ought never to have been employed in such delicate experiments as those on the present subject, in consequence of the certainty of its interfering action, vitiating the results. I regret I had not the means of making some direct experiments with cobalt to shew its interfering effects, but of their existence there can be no reasonable question.

2. Experiments on the magnetic influence of Solar Light, transmitted through Coloured Silk Media.

Having by the active and valued kindness of a friend, been supplied with an abundant assortment of coloured silks and cloth, I selected such colours as appeared to me best calculated to suit my purposes, and with these covered half of each experimental cylinder, exposing it subsequently, with due precaution, to the direct light of the sun.

The subsequent tables exhibit the results obtained.

TABLE VI.

Shewing Duration of Oscillations of Testing Needle, with Cylinder F in front, before and after exposure.

MEDIUM WHITE SILK.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						
1	22d	10	1	2	0·05	66°	92°	10	88	85	
2	...	...	...	...	...	...	...	10	88	86	
3	...	...	...	...	...	...	...	10	88	86	
4	...	...	...	...	...	...	...	10	89	86	
5	...	...	...	...	...	...	...	10	87	85	
						Sums		50	440	428	
						Means		10	88	85·6	

There is here a small indication of increase of intensity to the 2.4′ but no signs of Polarity could be obtained, the result is therefore doubtful, especially as the next series, incline in the opposite direction.

TABLE VII.

Shewing Duration of Oscillations of Testing Needle, with Cylinder G in front, before and after exposure.

MEDIUM BLUE SILK.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillation.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						
1	22d.	10½	1½	2	0.04	70	92	10	95	96	
2	...	...	...	...	...	...	...	10	96	96	
3	...	...	...	...	...	...	...	10	96	96	
4	...	...	...	...	...	...	...	10	96	96	
5	...	...	...	...	...	...	...	10	96	96	
						Sums ...		50	479	480	
						Means ...		10	95.8	96	

TABLE VIII.

Shewing Duration of Oscillations of Testing Needle, with Cylinder H in front, before and after exposure.

MEDIUM PURPLE SILK.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillation.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						
1	22d.	11	2	2	0.05	72	88	10	95	95	
2	...	...	...	...	...	...	...	10	95	94	
3	...	...	...	...	...	...	...	10	96	94	
4	...	...	...	...	...	...	...	10	95	95	
5	...	...	...	...	...	...	...	10	95	94	
						Sums	...	50	476	472	
						Means	...	10	95.2	94.4	

TABLE IX.

Shewing Duration of Oscillations of Testing Needle, with Cylinder I in front, before and after exposure.

MEDIUM GREY SILK.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						
1	22d.	11¼	2¼	2	0.05	72°	90°	10	90	91	
2	...	...	...	...	...	...	...	10	91	90	
3	...	...	...	...	...	...	...	10	91	91	
4	...	...	...	...	...	...	...	10	91	91	
5	...	...	...	...	...	...	...	10	91	91	
						Sums	...	50	454	454	
						Means	...	10	90.8	90.8	

This series gives the Duration of Oscillations before and after Exposure identically the same, the time being three hours, and the difference of temperature 18°.

TABLE X.

Shewing Duration of Oscillations of Testing Needle, with Cylinder K in front, before and after exposure.

MEDIUM BLACK SILK.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						
1	24th	10	1½	2	0.04	70°	99°	10	98	96	
2	...	...	...	...	...	...	...	10	98	96	
3	...	...	...	...	...	...	...	10	98	97	
4	...	...	...	...	...	...	...	10	98	97	
5	...	...	...	...	...	...	...	10	98	97	
						Sums	...	50	483	490	
						Means	...	10	98·8	96.6	

TABLE XI.

Shewing Duration of Oscillations of Testing Needle, with Cylinder L in front, before and after exposure.

MEDIUM-YELLOW SILK.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before. Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						
1	24th	10	1½	2	0.05	70°	109	10	86	86	
2	...	...	...	...	...	...	...	10	87	86	
3	...	...	...	...	...	...	...	10	86	86	
4	...	...	...	...	...	...	...	10	86	86	
5	...	...	...	...	...	...	...	10	86	86	
						Sums	...	50	431	430	
						Means	...	10	86.2	86	

The results of these various experiments with coloured silk media appear to me to shew very distinctly that the light transmitted through them possesses no magnetic properties whatever. Had it been otherwise, that want of uniformity which marks the general results exhibited by the tables, would not have prevailed, and had the increase of intensity been in any way equivalent to that specified by other observers, the apparatus employed would, I doubt not, have indicated it distinctly. The silks employed were of various textures, but in no single instance, even when slight variations of magnetic condition were indicated by the testing needle, could the characteristic polar action of magnetised substances be obtained. Formerly expressed opinions, therefore, of the non-existence of any magnetic influence in solar light, receive additional confirmation from the preceding experimental results.

3. Experiments with Coloured Cloth Media.

From an anxiety to set at rest, if possible, the long disputed question of magnetic influence in light under any circumstances, I determined to make some few experiments with cylinders exposed as before, under differently coloured pieces of cloth. The texture of the cloth admitted, to a certain extent, of the permeation of light, and the forms of experiment were in every respect the same as in the series immediately preceding. To multiply observations when I found the results conformable to previous ones, appeared to me unnecessary; the number of tables, under this branch of the section, is accordingly but limited, although still sufficiently extensive to warrant the inferences made.

TABLE XII.

Shewing Duration of Oscillations of Testing Needle, with Cylinder M in front, before and after exposure.

MEDIUM RED CLOTH.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
1	Feb. 24th	11¼	2¼	In. 2	In. 0·05	70°	102°	10	99	100	
2	...	...	...	...	...	...	...	10	100	99	
3	...	...	...	...	...	...	...	10	99	100	
4	...	...	...	...	...	...	...	10	99	99	
5	...	...	...	...	...	...	...	10	100	100	
						Sums ...		50	497	498	
						Means ...		10	99·4	99·6	

TABLE XIII.

Shewing Duration of Oscillations of Testing Needle with Cylinder N in front, before and after exposure.

MEDIUM GREEN CLOTH.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before. Expos.	After Expos.		Before Expos.	After. Expos.	
	Feb.			In.	In.						
1	24th	11½	2½	2	0.05	70°	102°	10	98	98	
2	...	...	...	...	...	...	...	10	98	98	
3	...	...	...	...	...	...	...	10	99	99	
4	...	...	...	...	...	...	...	10	99	98	
5	...	...	...	...	...	...	...	10	99	99	
						Sums	...	50	493	492	
						Means	...	10	98·6	98.4	

TABLE XIV.

Shewing Duration of Oscillations of Testing Needle with Cylinder O in front, before and after exposure.

MEDIUM ORANGE CLOTH.

No. of Exp.	Date of Exp.	Hours of Expos.		Length of Cylin.	Diam. of Cylin.	Temp.		No. of Oscill.	Duration of Oscillations.		Remarks.
		From A. M.	To P. M.			Before Expos.	After Expos.		Before Expos.	After Expos.	
	Feb.			In.	In.						
1	24th	11¾	2¾	2	0·04	70°	101°	10	98	97	
2	...	...	...	...	...	...	...	10	98	98	
3	...	...	...	...	...	...	...	10	98	97	
4	...	...	...	...	...	...	...	10	98	98	
5	...	...	...	...	...	...	...	10	98	9	
						Sums	...	50	490	488	
						Means	...	10	98	97·6	

From these three tables, it accordingly appears that cloth media, are not more successful in displaying the magnetic influence of light, than are those of glass or silk; and the general conclusion warranted by the entire series of experiments now detailed, is distinctly and decidedly opposed to the theory of such influence. The following Table exhibits in a condensed form the experimental results obtained, and will shew at a glance, the evidence on which the above inference is founded. I may premise that the term differential of temperature is employed to indicate the difference between the temperature before and that after exposure, while differential of oscillation shews the difference of the durations of oscillation under the same circumstances. When the duration before exposure exceeds that after it, the sign + is prefixed to the differential, when the converse is the case, the sign — is employed.

TABLE XV.

Shewing General Results of Experiments on the Magnetic Influence of Solar Light, transmitted through coloured media.

No.	Cylinder.	Nature of Medium.	Diff. of Temp.	Diff. of Oscill.	No.	Cylinder.	Nature of Medium.	Diff. of Temp.	Diff. of Oscill.	Remarks.
				Sca.						Diam. of Cylinder A,C,D,E, F,H,I,L,M,N,= 0·05 In. Diam. of Cylinders B, G,K,O = 0·04-No. 6, very doubtful.
1	A	Glass.	36°	—0·4	8	H	Silk.	16°	+0·8	
2	B	Do.	18°	—0·4	9	I	Do.	18°	0.0	
3	C	Do.	27°	+1·5	10	K	Do.	29°	+1.4	
4	D	Do.	24°	+0·8	11	L	Do.	39°	+0·2	
5	E	Do.	19°	—0·2	12	M	Cloth.	32°	—0-2	
6	F	Silk.	26°	+2.4 ?	13	N	Do.	32°	+0.2	
7	G	Do.	22°	—0·2	14	O	Do.	31°	+0·4	

The very trifling departures from equality between the duration of oscillations before and after exposure, as indicated by the last column of differentials, in combination with the circumstance that these departures are sometimes on one side, sometimes on the other, shew very clearly that no force, *constant in its direction*, could have acted upon the testing apparatus, and the theory of the magnetism of solar light which implies such a force must accordingly be finally abandoned. Nor is the settlement of this singularly fated question, a matter purely of speculative interest, since it has been intimately interwoven with the theories of terrestrial magnetism and temperature, whose many important practical applications renders it of moment that no erroneous assumptions should be connected with them. M. Kupffer, the distinguished Russian traveller, in an able and interesting essay on the distribution of temperature throughout the world, makes the magnetic influence of solar light a fundamental portion of the hypothesis he adopts, and views the earth, not as is generally done, as having an independent magnetism, but as a mass highly susceptible of magnetism, and rendered magnetic by the influence of a distant celestial body. He displays much ingenuity in reconciling his observations on the arrangement of Iso-geothermal lines with this view, but his labours of course, now become useless, when it is shewn that the foundation of his theory is unsound, and that the magnetic influence of the sun's rays, on which he rests so much, has no real existence as a power in nature.

Camp, 20th May, 1842.

On the Manufacture of Bar Iron in Southern India. By Captain J. CAMPBELL, *Assistant Surveyor General, Madras Establishment.*

1. In the commerce between India and England, a source of deep injury to the former country arises from England having deprived her of the trade in cotton cloth, the manufacture of which was, but a few years ago, one of the most valuable and extensive of Indian products; while from no other having been as yet introduced as an export to balance the imports from England, it has become necessary to drain India of her specie to pay the expences of the Government, and for the articles she requires from the

mother country. The Government both in England and in India have therefore been unremitting in their endeavours to promote and foster the export trade from India; and in the mean time have endeavoured to economise by means of the internal productive resources of the country, and thus in some measure reduce the export of specie, and at the same time disseminate a knowledge of practical manufacturing processes.

2. Among the most extensive of the exports of England to India, is the trade of bar iron, which to Madras alone amounts to 1,000 tons per annum; and while India is known to produce malleable iron of a superior quality, it has been frequently proposed as a question whether she could not supply her own wants in this article at a cheaper rate than if procured from England, if improved processes were introduced in the reduction of the native ores. I am not aware that any satisfactory experimental investigation of this point has ever been instituted, or given to the public; but from the remarks in the reports of the Committee for investigating the coal and mineral resources of India, it would seem that little or nothing is as yet known upon the subject.*

3. English iron is not used inland in Southern India, in consequence of the great expence of land carriage, and from the same cause, it is probable, that in Northern India also, the only iron used is that made upon the spot; and as the manufacture must be very limited in quality, it becomes

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* It has been supposed by the Committee, that it would be more desirable in the first instance to make good cast iron, than to attempt to improve the bad wrought iron of the country; and with the view of instituting an extensive set of experiments on the subject, a furnace has been erected at the Mint at the suggestion of Major Forbes, one of the Members of the Committee. Some delay took place in providing the necessary apparatus, but everything being now ready, experiments will shortly be entered upon for the production of cast iron. The valuable suggestions of Capt. Campbell contained in this paper will be duly brought to the notice of the Committee.—Ed.

of much importance, both to individuals and to the Government, to be acquainted with the mode of supplying any extraordinary demand. Indeed, we are informed by Captain Drummond, in the Journal of the Asiatic Society of Bengal, that the carriage of a suspension bridge erected in Kemaon, alone cost about 80 rupees per ton, or as much as the iron might have been made for upon the spot.

4. In projecting the establishment of a new manufacture, persons are but too prone to copy an old established process, without studying sufficiently the principles by which the result is produced, so as to be able to modify the mode of operation to suit the resources of the locality, and the capabilities of the workmen; and because the English mode of manufacturing iron has been found to be the most profitable in England, it has been supposed that a similar process could alone answer in India. This process has also been styled "scientific," but the fact is, that the principles of the mode of operation are still totally unknown, and the manufactures are not only unable to produce at pleasure a certain result, but even the quantities of the results produced depend upon the weather, and other causes as yet not explained, or beyond the control of the workmen. We do not as yet even know what cast iron is; nor with any certainty what its component parts are; nor in what it differs from steel, or the varieties of what are generally called carburets of iron. On this point Barlow remarks, (Encyclopedia Metropolitana,) "There is certainly much to be learned in the iron trade, before we can boast of any thing like a complete knowledge of its different processes. We observe many facts in this, as well as in other branches of the manufacture, of which, the most we can say is, that they are connected with, or caused by certain other accompanying facts, though we are ignorant how this connection exists; often, indeed, our knowledge does not extend so far." Again, "it is, however, so difficult to follow up chemical analysis, and to ob-

tain results with minute accuracy, in a process requiring intense heat, that hitherto the phenomena attendent upon the refining of pig iron, and its conversion into bars, may be said rather to be guessed at, than perfectly explained." Upon the same point also Dr. Ure remarks, (Dictionary of Manufacture,) " but philosophers have been, and still are, too much estranged from the study of the useful arts, and content themselves too much with the minutiæ of the laboratory and theoretic abstractions." Such being the state of our present knowledge of this subject, it may be doubted if a careful examination of the principles of the long established, cheap, and simple mode of manufacture of the native of India, might not lead to improvements and modifications, which would be found to answer better, than the operose methods of the English manufacture, which require much capital, costly building, and a considerable trade to make them profitable.

5. In England the fuel now most generally used in smelting the impure iron ores of the coal fields is coke; and the ore after being first roasted to separate the volatile impurities, as much as possible, is exposed to its action in blast furnaces, generally about forty-five feet in height, but varying sometimes from thirty-six feet to even sixty feet. In the middle, these furnaces are about twelve feet in diameter, but at top are contracted to about four feet, and at bottom, where the blast of air is introduced by pipes from powerful blowing machines, the diameter is only about two feet. The pressure upon the air forced into the furnace is about three pounds upon the square inch, and the quantity of air amounts generally to as much as 4,000 cubic feet per minute. The cast iron as it forms, falls down into the bottom of the furnace; which is always hot enough to maintain it in a state of fusion; where it is protected from the action of the blast by a covering of fused slag which floats upon it. These furnaces are kept in action unremittingly, night

and day, for several years together; the metal being allowed to flow out every twelve hours in quantities of about six tons at a time. The material used in building the blast furnace is principally fire brick, and a pair of furnaces cost upwards of 1,800*l.* sterling. The proportion of coal used in making a ton of cast iron, varies very much, from three tons in Wales, to sometimes eight tons in Derbyshire; but the use of heated air in blowing the furnaces has very much increased the quantity of the products of the blast furnace, and has also diminished the expenditure of fuel, but the quality of the cast iron is said to be deteriorated. The estimated expense of making a ton of cast iron is about 3*l.* sterling.

6. For converting cast iron into bar iron, the first process generally employed in England is called "refining," and consists in fusing about a ton of cast iron at once in flat open furnaces about three feet square, where it is exposed for two hours or more to the action of a strong blast, by which it is supposed a portion of the carbon it contains is burnt off. Much gas escapes from the surface of the metal during the operation, and a large quantity of black bubbly slag separates, after which the metal when run out and allowed to cool, has a white silvery appearance, is full of bubbles, is very brittle, and has acquired the property of hardening by being suddenly cooled. In "refining," about four or five hundred weight of coals is used to the ton of cast iron, and the metal loses from twelve to seventeen per cent of its weight.

7. The "refined" cast iron, now termed "fine metal," is then exposed in a reverbatory furnace, called the "puddling furnace", to the action of the flame of a large coal fire, by which it is first partially melted, then falls into a coarse powder; and on being stirred up and presented to the flame, becomes at last adhesive and tenacious. It is then formed into large balls, and after receiving a few blows from

a large hammer to consolidate it, is passed between rollers which squeeze out much of the impurities, and form it into "mill bar iron." This is however too impure for use, and it is necessary to cut the rough bars into pieces and to weld them together afresh, in a "reheating furnace," and expose them to another rolling, and even to repeat the operation a third time, before good tough bar iron is produced. In the "puddling furnace" about a ton of coals is expended to each ton of "fine metal," and in the "reheating furnace," about 150 pounds more are expended; and in each operation a loss of about ten per cent. takes place in the weight of metal operated upon.

8. Upon an average about nine tons of coals are expended in England in forming one ton of finished bar iron, and it is probable, that if the above processes were attempted upon any smaller scale than that of the English works, a still greater quantity would be used. Some of these works cost 27,000*l.*, and turn out 120 tons of bar iron per week.

9. In France, Sweden, Norway, and parts of Germany, the fuel principally used is charcoal, and the ores are pure oxides of iron; the furnaces are about thirty feet in height, and in shape resemble in great measure the blast furnaces of England. Leathern forge bellows are frequently used to blow them, and the results vary from five hundred weight of cast iron per day, to sometimes five tons. The quantity of charcoal used also varies very much, from one and quarter ton, to two and half tons for each ton of cast iron, according to the nature of the mineral oxide smelted.

10. The cast iron thus made is treated with charcoal in a refining furnace, not differing much from the English ones, but the metal is not allowed to run out, the operation being continued for nearly five hours, until the metal has become tenacious and adhesive, when it is removed in lumps of about two hundred weight each, which are forged under a

large tilt hammer, then cut into smaller pieces, and is drawn out into bars at once. In this process the metal loses about twenty-six per cent. of its weight, and 149 pounds of charcoal are consumed for every 100 pounds of iron produced.

11. Formerly a kind of furnace called in Germany a "steuck often" was sometimes used, which was from ten to fifteen feet high, and three feet in diameter, resembling very much an iron founder's cupola furnace, but with a larger door, which was broken open after the operation was finished, which required about twelve hours, and the lump of cast iron weighing about a ton, was removed with powerful tongs to the refining furnace. The quantity of charcoal used was from two and a quarter to three and a half cwt. for every cwt. of cast iron, and about one and half cwt. more was required in the refining and forging, making the whole expenditure from four to five cwt. for every cwt. of bar iron.

12. In some parts of France, malleable iron is made at once from the mineral oxides of iron, in what are termed "catalan forges," which are cavities about 16 inches square, and two feet in depth, sunk in the floor of the workshop, the blast being thrown in by a pipe sloping towards the bottom of the furnace. The cavity being filled with charcoal, the ore is added in small quantities, alternately with fresh charges of charcoal, and in about five or six hours a lump of iron is procured, weighing from two to four cwt. which is removed, and forged at once into bars. The expenditure of charcoal is very great, amounting sometimes to eight times the weight of the iron procured. But when wood is cheap and abundant, there can be little doubt this process would be a convenient one for smelting any of the mineral peroxides of iron.

13. The mode of smelting iron used by the natives of India, appear to be very much the same from the Himalayas down to Cape Comorin, and in some degree resembles that alluded to in paragraph 11.

The ore principally used is either the common magnetic iron sand found in the nullahs, or else pounded magnetic iron ore, separated from the ferruginous granite, (described at page 165, vol. ii.,) but I have seen specular iron ore used by the Konds of Goomsoor.

14. The material used for the native furnaces, is the common red potter's clay of India, which unless carefully selected, is not generally very refractory, and will hardly stand a heat sufficient to fuse cast iron, but by mixing it with sand, and by concentrating the heat in the centre of the furnace as much as possible by a projecting blast pipe, the reduction of the ore is effected before the furnace has become much more than red hot; the operation being completed in about a couple of hours.

15. In constructing these furnaces, a platform about two feet square and five inches thick is first made, with a hole in the centre nine inches in diameter. A half-cylinder or curved piece is then formed also of the red clay, eighteen inches high, four inches thick, and thirteen inches diameter inside, and the same depth, and also a cone about two inches thick of the same height, and the same diameter at bottom, and seven inches at top. When these are quite dry, a little wet clay being put round the hole in the platform, the half-cylinder is placed upon it, and the open front is built up with clods of clay, and the inside part is plastered for two inches thick until a hollow cylinder is produced, about twenty-three inches deep, nine inches in diameter inside, and about six inches thick. When nearly dry, an arch is cut out in front at bottom about nineteen inches high, to form the door of the furnace. The cone is then placed on the top, and the inside plastered with clay to correspond with the bottom part, and the neck or throat reduced in the same way to about five inches diameter. The upper part of a chatty with the neck is then placed inverted on the apex of the cone, to form a funnel to conduct the charge into

the throat, and the chatty and the whole of the outside of the furnace is then plastered over with clay about two inches thick, so as to give the appearance of a large sugar loaf enlarged a little at the point. When finished, the height inside from the bottom to the neck is about three feet ten inches, and the whole takes about a week to finish before it is quite dry.

16. The blast pipe is a cylinder of dried clay fourteen inches long, and about four inches thick, pierced with a hole of an inch in diameter. It is introduced into the furnace at the bottom of the door, with the point about the centre of the furnace, and about five inches above the bottom. The door is then closed with a tile of dried clay, and the outside is built up and secured with wet clay plastered over, a layer of charcoal dust, about two inches thick, having been first placed at the bottom of the furnace to prevent the reduced oxide adhering to it.

17. The bellows are two goat skins taken off the animal, by opening the hinder part only. The orifices at the legs are sewn up, and a piece of bamboo is inserted, and tied tightly into the neck of each skin, and these bamboos being inserted into the outer part of the blast pipe, which is made conical for that purpose, the vacant openings are then stopped with wet clay. The open end of the skin is finished by folding the edge of one side, as a flap, about four inches over the other edge, and sewing up the upper and lower corners, so as to leave a part of both flaps open for about nine inches. When the skin is filled with wind, and pressed, the inner flap closes therefore against the outer, and stops the passage. Each skin is managed by one man, who places it in his lap, and squeezes it down with the elbow and lower part of the right arm, grasping at the same time a projecting sort of handle of leather, formed at about the part where the tail of the animal might have been. To enable the blower to fill the skin again with wind, a piece

of string is attached to the lower corner of the posterior part, which is tied to a peg driven into the ground about a foot behind the man's elbow, and keeps the skin distended to its full extent as it lays in his lap; and a loop of leather is also fastened to the outer flap, through which the arm is passed, by which the opening into the skin is distended upon raising the elbow; and the skin being pulled out horizontally by the neck in one direction, and the string and the peg in the other; upon pulling up the middle part vertically by the leather grasped in the hand, the skin is opened out into a triangular shape, and fills with wind through the open flap. While squeezing the skin in blowing also, by pressing the hand forward, so as to pull against the string attached to the posterior part, the valve flaps are made to close fairly and properly, so as to allow hardly any wind to escape. The left hand is employed in assisting the right, or in squeezing the distended parts of the skin upon the side. It will be observed, that as both the necks of the skins open into the blast pipe, a portion of the wind expelled from one skin passes back again into the other; as they are worked alternately, a defect which might have been remedied in a most simple manner, by attaching little hanging door valves to the ends of the pipes.

18. A small quantity of charcoal being thrown into the furnace, the fire is introduced, and the blast commenced, and the furnace is filled to the neck with about twenty-six pounds of charcoal. In about half an hour flame issues from the throat, and the fuel begins to sink, at which time the charge is commenced, which consists of ten pounds of charcoal and five pounds of ore, wetted to prevent it running down too fast. The charge is repeated seven times, and the furnace is allowed to burn down, and in about two and a half hours as soon as welding heat sparks are seen to issue with the flame, the bellows are removed; the door broken open; and the lump of reduced iron is removed, and

cut open while hot with a hatchet, to shew the quality. Four men are required to work one of these furnaces, one being a maistry superintendent, and the other three labourers, and they are able to make about three lumps in in a day of twelve hours, but after four days' work, the lining of the furnace is destroyed, and requires renewal.

19. The lumps which result from the native furnaces weigh about eleven pounds, and are sold sometimes at the rate of two annas each. They are not, however, all iron, and on bringing them to a welding heat in a forge, a large portion consisting of fused oxide, melts away, and the best lumps which I have examined yield only about six pounds of iron, (generally they do not contain more than three pounds.) Taking forty rupees a ton as the expence of forging the iron into rough bars by hand hammers, we shall have eighty rupees a ton as the expence of bar iron, made with these diminutive furnaces, which is less than the present market price at Madras of the cheapest English bar iron. In my experimental investigation of the best methods of managing small blast furnaces, not larger than the native ones, I have found that two men can procure in a day's work of twelve hours forty pounds of crude iron, with an expenditure of half the quantity of charcoal and ore used by the natives. Furnaces of this size offer therefore a cheap, convenient, and ready mode of smelting iron wherever charcoal is abundant.

20. Although the aggregate manufacture of iron in India is no doubt very considerable, yet from the difficulty of inland transport in Southern India, it is probable that no extensive iron works will ever be established by European capitalists; and the only improvements which are capable of being introduced with advantage, or may be within the comprehension of natives, are those by which the expenditure of fuel may be economised by increasing the size of the furnace, and by which a sufficiently powerful blast may be

produced. From my own experiments, I am led to believe, that the catalan forge will not answer except when the ores of the peroxide are procurable, in consequence of a peculiar property possessed by the magnetic oxide. But I am of opinion that the German, "steuck often" might be used with great advantage, and the complete reduction of the ore at one operation to malleable iron, is easily effected. One of these furnaces may be easily built for ten rupees. The bellows for it may cost about ten rupees. A small tilt hammer about fifty rupees, and the whole stock in trade capable of turning out a ton of bar iron per week, need hardly cost one hundred rupees. I believe that nearly all the jungly tracts of Southern India are granitic, and in them of course fire clay and magnetic iron sand abound. Charcoal can be made at about fifty pounds for an anna, and the iron sand is sold at thirty pounds for an anna, which prices are as cheap as the iron stone and coal are now sold for in South Wales.

21. With regard to the quality of the iron produced by the native methods, we have the most contradictory remarks from various authors; and indeed I am not aware of any good researches upon this point having been published. From what I have seen of Indian iron, I consider the worst I have ever seen to be as good as the best English iron, and that its supposed defects arise from its almost always containing a considerable portion of steel.

22. If it is attempted to bend a bar of English iron of inferior quality when cold, it will be found to snap short off, almost without bending at all, and the fractured end will exhibit a series of minute glistening planes inclined at irregular angles, and which by the lens, will be seen to resemble exactly the spangles of "kisk," or graphite, which appear upon the surface of highly carburetted cast iron. A bar of the best English bar iron, when bent cold, will exhibit on the sides of the bent angle a series of longitudinal fissures,

evidently produced by impurities between the fibrous portions, and before it is bent as far as an angle of 120°, it will break, and the fracture will be half glistening, and the rest very much resembling lead when forcibly pulled asunder. This last portion is the pure iron, and when viewed endways, will generally appear nearly black. The glistening portions are portions of carburet imperfectly reduced. It is a common remark of authors, that pure iron is either granular or fibrous in texture, the former being produced by sudden cooling, and the latter by elongation under the hammer. This remark I consider, however, to be erroneous, and I have never found pure fibrous iron to become granular, if properly worked, although granular iron will become fibrous; not, however, by the mechanical effect of the hammering, but by the action of the fire and blast reducing the carburet. In working the best kinds of English iron, they let fall upon the anvil a quantity of red powder, which very much resembles in appearance the residue left by burning the carbon separated by muriatic acid from cast iron. Even the charcoal-made English iron will hardly bear drawing out under the hammer without splitting, and a small rod will generally snap after bending it two or three times. English hoop iron, although it will stand curling up into a roll of about $\frac{1}{4}$ inch in diameter, yet on the slighest attempt to bend it longitudinally into a hollow trough, it will crack in three or four places immediately. The following remarks by Dr. Ure, (Dictionary of Manufacture,) are evidently from a person practically acquainted with the subject. "The quality of iron is tried in various ways; as first by raising a bar by one end, with the hands over one's head, and bringing it forcibly down to strike across a narrow anvil at its centre of percussion on one-third from the other extremity of the bar, after which it may be bent backwards and forwards at the place of percussion several times. 2. A heavy bar may be laid obliquely over props near its end, and struck strongly with a hammer with a narrow pane, so as to curve it in opposite directions, or while heated to redness, they may be kneed backwards and forwards at the same spot on the edge of the anvil. This is a severe trial which the hoop (Swedish iron) bears surprizingly, emitting as it is hammered, a phosphoric odour peculiar to it, and to the bar iron of Ulverstone, which also resembles it in furnishing a good steel. The forging of a horse-shoe is reckoned a good criterion of the quality of iron.

23. There is hardly one of the above tests, which good native iron of Southern India will not bear, and some iron which was produced in my own furnaces, has stood drawing out under the hammer into a fine nail rod not $\frac{1}{10}$th inch thick, without splitting, and when kneed backwards and forwards, only broke after six or seven times. When twisted like a hank of whipcord until some of the plies began to draw out, no fracture occurred in any part, and a half inch bar $\frac{1}{4}$ inch in thickness bore doubling together *cold*, and the angle hammered down close with very little signs of separation between the fibres. As I have shewn that native Indian iron contains steel, the quality can be easily tested by a very simple method, which is merely to bring the middle part of the bar to a red heat, and then immersing it in water, by which all the steely portions will be rendered brittle, without the fibrous portions being affected. An inch bar of good iron thus treated will bear a dozen blows of a heavy sledge hammer before it will break.

24. The fractured end of a bar of Indian iron presents a very different appearance to that of English, none of the glistering portions being visible, but if not fibrous, it shews the granular fracture of an aggregation of crystalline grains, either large or small, according to the hardness of steel which it contains. The iron thus examined may be separated for different purposes into four different kinds.

1st. Completely fibrous. Fit for nails, horse-shoes, bolts, straps, crow-bars, tongs, &c., in which softness is of no consequence, and great tenacity and ductility are requisite.

2nd. Half fibrous and half granular. Fit for axle trees, wheel tyres, &c., where tenacity and strength are both requisite.

3rd. Nearly all granular and steely, resisting the file in some parts, and brittle, breaking with one or two blows of the sledge. Fit for lathe bars and iron work in mathematical instruments, where hardness is requisite to prevent bruising.

4th. All granular, with the fine snow-white fracture of cast steel in parts. Only touched by the file in some parts. Very brittle unless annealed. Hard, and resists the hammer in forging, drawing out with difficulty, and cracking slightly at the edges unless carefully forged. Fit for plough shares, spades, and pickaxes, bricklayers' trowels, &c. which require to be hard.

25. Some native made iron which I have met with was difficult to forge, from its cracking very much under the hammer at the edges of the bar, though not otherwise deficient in tenacity; but as such iron is not common, I have not had opportunities of examining it properly. The native workmen say, that iron of this kind is quite as ductile as any other if it is forged with bamboo charcoal. Should this be a fact, it seems to be well worth the attention of chemists, considering that the coat of the bamboo contains much finely divided silica, and remembering that the English smiths, when welding together steel and iron, use freely large quantities of a white quartzose sand. It is probable that it is this last kind of Indian iron, which has by some been called "red short," which is however a mistake. The English red short iron snapping off like a carrot when bent.

Description of the Sungn̤ái, Cervus (Rusa) frontalis, McClell., a new species of Deer inhabiting the valley of Moneypore, and brought to notice by Captain C. S. GUTHRIE, *Bengal Engineers. By* J. M'CLELLAND. *Plates* xiii. *and* xiv.

In order to account for so large and interesting a species remaining so long undiscovered, as well as for its range being limited, as far as our information yet extends, almost to the Moneypore valley and its vicinity, it is necessary to consider the general features of the mountain tract on the Eastern Frontier of Bengal.*

The best, and indeed the only description of this region extant is contained in the Report of the late Captain R. B. Pemberton, on the Eastern Frontier, printed in Calcutta, 1835, by order of the Government of India. The region in question consists of mountain chains, which extending from the Himalaya under the lat. 23° N., long. 95° E. separate the great basins of the Irrawadi and the Burrampooter. It is bounded on the South-west by the plains of Bengal, on the East by the plains of the Irrawaddi, on the North by those of the Burrampooter and by the Himalaya. It affords several considerable vallies at various elevations of from 1,000 to 2,500 feet above the sea, of which the most considerable is Moneypore. It also presents some still more elevated table lands of from 4,000 to 5,000 feet.

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* Capt. Eld, Journ. Nat. Hist., vol. ii. p. 417, conceives that there would be great difficulty in rearing the young of this species removed from its native climate, I have therefore availed myself of the scarce and valuable work of Capt. Pemberton, in order to afford as correct a view of the climate in which it lives as possible. Both Capts. Guthrie and Eld, appear to think that the species is strictly confined to the Moneypore valley, but Mr. Henry Inglis informed me that it is found, though rarely, in the Kasyah mountains, (a part of the same chain,) in the winter season, at elevations I think of four or five thousand feet.

The loftiest peaks attain an elevation of from eight to ten thousand feet above the sea. Thus formed under the parallel of 22° to 24° North lat., partially bordering the sea on the West, and the Himalaya on the East, the climate of this region must be subject to many peculiar influences. From a statement given by Capt. Pemberton of the quantity of rain at Moneypore, it appears that the annual fall is heavier than it is in Bengal. It amounted on an average of three years to 115 inches, while in Calcutta the mean fall for the same period was but 72 inches per annum. The rain is also more equally diffused throughout the year, particularly during the months of March, April, and May, than in Bengal. During this period also, the temperature is on an average 15 degrees lower at Moneypore than in Calcutta; and though hoar-frost is common during the months of January and February, yet the thermometer rarely falls to the freezing point.

There is another circumstance which though not peculiar to this region, yet deserves to be mentioned. During cold weather, Capt. Pemberton states, from about the end of November to the beginning of January, the whole valley is enveloped until ten or eleven o'clock daily, in a dense fog which ascends from the surface of the ground to an elevation of fifty feet. Viewed from the summits of the surrounding heights, it looks like a vast bed of snow, and rests perfectly motionless, until dissipated by the reflection of the sun's rays from the face of the surrounding ranges which overlook the valley.

The surrounding mountains are in most instances, says Capt. Pemberton, covered with the noblest forest trees, common both to temperate and tropical climates. Cedars of gigantic size crown the summits of the loftier ranges immediately west of Moneypore; oaks of every size, from the most stunted, which are confined to the lower ranges, to the most majestic, which are on the loftier ones, grow in luxuriant abundance in every part of the country. Toon, red teak, pines, and other gigantic trees with which Capt. Pemberton was unacquainted, are found in the greatest profusion on the hills to the South-east of Moneypore.

Of the geological structure of this tract, Capt. Pemberton remarks, our knowledge is particularly incomplete; the prevalence of dense impervious forests, extending from the summits of the mountains to their bases, has restricted observation to those portions that have been laid bare by the action of torrents, and to some few of the most conspicuous ridges. In that portion of the tract which extends between Moneypore and Cachar, a light and friable sandstone of brown colour, and red ferruginous clay are found to prevail on the lower heights.

Sandstone seems to be the most prevalent rock in the central ranges between Moneypore and Bengal; with this, coal-slate, and limestone occasionally occur. The northern ranges between Moneypore and Assam are composed of more compact rocks, and the great central ridge of this part of the chain consists of hard grey granular slate, and on the northern face of this chain, boulders of granite were found resting on the inferior heights. These mountains are inhabited, Captain Pemberton remarks, by fierce unconquered tribes, whose aggressions on the inhabitants of the subjacent plains have led in many instances to the payment of a species of black mail, to procure exemption from their attacks; and even those who from among our own subjects had ventured amongst their fastnesses, scarcely ever penetrated beyond the first ranges which immediately overlook the low lands of Bengal and Cachar. But a road is now open from Bengal into the Moneypore valley, where there is a British Resident. There are, however, only two instances of Europeans having been permitted to cross the northern range of mountains from Moneypore to Assam. The first attempt was successfully accomplished by Capts.

Jenkins and Pemberton in 1832; the second by Lieut. Gordon the following year, attended by the Rajah of Moneypore himself, when, notwithstanding the personal influence of the Rajah, the protection of a military force was necessary, as well as recourse to fire arms.

Of the wild animals, Capt. Pemberton mentions, herds of elephants are constantly seen in the glens and defiles on the north of the Moneypore valley. Deer, he says, abound in every part of the country, and grow to a very considerable size. He does not specify the varieties, but some of the deer alluded to, were doubtless the species now about to be described. The wild hog, he says, is no less abundant, and its ravages in the fields are sometimes so great, that the villagers are compelled to go out in a body against them; and when ponies were more numerous, the pursuit of the deer and hog ranked amongst the most favourite sport of the Moneyporees.

Having now at length arrived at the proper subject of this communication, it may be commenced by stating, that in 1839, I received from Capt. C. S. Guthrie, a specimen of the horns of a young deer of the Rusa group, with a request to notice the peculiarity which seemed to indicate a new species. The specimen was deposited in the Museum of the Asiatic Society, in which I happened then to be interested.

In the fourth number of the Calcutta Journal of Natural History, p. 501, the peculiarity referred to by Capt. Guthrie, was pointed out and figured, pl. xii. vol. 1, and further enquiry was there strongly recommended. Capt. Eld, one of the Principal Assistants to the Commissioner of Assam, and who had been previously attached to the British Residency in Moneypore, having had his attention called to the notice and the figure alluded to, soon after addressed an interesting letter on the subject to one of the contributors to this work, affording the first general information hitherto received relative to the habits and character of this interesting species. As Capt. Eld's letter is recorded, vol. ii. p. 415, it will be unnecessary here to do more than refer to his observations, which are highly important and valuable, as coming from a sportsman who was familiar with the animal in its wild state. It would appear from the letter of Capt. Eld, that he had been acquainted with the animal since 1838, and was only deterred at that time from communicating an account of it to the public journals on being told, that a similar deer was to be found in the forests of the North Western Provinces. Had Capt. Eld not been deterred from carrying his intention into effect, he would then have had the priority of all other claims in contributing to the discovery of an unknown animal of much interest; but as he did not carry his intention into effect, his prior knowledge cannot deprive Capt. Guthrie of any portion of the very high degree of merit indubitably due to him, and to him alone, as the first person to announce to the world the existence of *Cervus frontalis*. But this is not the only merit due to Capt. Guthrie in this instance, for not satisfied with the first announcement of a new fact, he devoted three years' labour and attention in procuring skeletons and skins, and heads, in every degree of development and livery, in order to establish, beyond doubt, the discovery which he was first to indicate, and to enable the world to become practically acquainted with it.*

Although differing considerably in the form of the horns from any of the *Rusa* deer, still the general form, the colour,

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* It is of much consequence to preserve strictly, the exact degree and nature of the claims of different persons to the share in which they have been instrumental in the discovery of new facts. While, therefore, we owe to Capt. Guthrie the first announcement of the species, as well as all the materials necessary for the fullest and most complete description, we likewise owe to Capt. Eld, an interesting account of its habits.

the mane, and the Asiatic habitation of the species, all seem to refer it to the *Rusa* group, of which it forms one of the most unique and striking examples.

Gen.—CERVUS, Lin.

Sub.-gen.—RUSA, Smith.

*Species.—Fontalis.** McClelland, pl. xiii.

The form of the skull agrees more with that of *Cervus hippelaphus*, than with that of any other species that I can refer it to, but the nasal and intermaxillary bones as well as the muzzle generally, seem to be somewhat more prolonged and compressed, and though the face is broad and flat between the eyes, the forehead is compressed, and the head as well as the muzzle narrow, and the profile nearly straight, but with a short prominent ridge commencing on the forehead, and extending between the horns. There are two canine teeth, not much developed in the upper jaw of both sexes, and the suborbital sinuses are large.

The horns are large and directed backwards, and obliquely outwards without ascending from the burr: they are then curved gradually upwards and outwards, and terminate in a point directed forward. A single small antler extends obliquely inward from the upper third of the horn; this antler in young individuals appears to form a fork with the summit, but in the adult it is placed about six or seven inches from the top point of the horn, and is more or less developed according to age; in the adult, and particularly in aged individuals, an imperfect nodular spine extends from the base of this antler towards the point of the horn, with several irregular blunt snags arising from it, forming an incomplete kind of crown.

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* The *Sungṇài* of Moneypore valley, (Capt. Guthrie,) according to the most careful regard to orthography; or *Sungraëë* of Capt. Eld, but the former we consider the most correct. The specific name, *frontalis,* is intended to denote the peculiar form of the brow antlers descending over the eyes.

The brow antler advances directly forward from the burr, and bending upwards and outwards, terminates in a point, which if prolonged, would meet the summit of the horn, and thus complete an almost perfect circle.

A single little snag sometimes shoots out promiscuously from the base of one or other horn, more frequently from that of the brow antler.

The length of the horn following the curve is three feet, and that of the brow antler twenty inches. The circumference of the horn is five and half inches, that of the brow antler five inches, and both together form one extended and uniform curve of four feet and seven inches; the horns spreading laterally from each other to a distance of three feet, and then approaching at their bases to an inch or an inch and half.

The body in its general symmetry is light; the limbs slender but strong; the hoofs long, black, and pointed; the head is carried erect; the tail short and conspicuous in the summer dress; but only appearing as a short tuft in the thick winter coat.

The coat is thick and dense in winter, longer and coarser on the neck than on other parts, forming a thick but undefined mane of straight, harsh, and coarse hair, five or six inches long in the winter, but in summer the mane is more defined. From the withers, the hair becomes shorter, diminishing towards the tail, which in summer is thinly clad, though in winter it is covered with a dense clothing of hair in common with all the upper-parts of the body. On the face, the muzzle, the limbs, and the external ears the hair is short, close, and compact; on the lower surface of the chest it is coarse and short; it is thin, lengthy, and fine on the under-parts of the belly. The inner parts of the thighs and upper and inner-parts of the forelegs, are also thinly clad.

The colour changes from yellowish brown in summer to a brownish grey in winter; during summer, brownish grey prevails on the face and neck, becoming yellowish brown on the upper parts of the body, the backs of the ears, and the upper and outer part of the limbs and the muzzle. The belly, the inner parts of the thighs and the forelegs, the under-parts of the lower jaw, the hips, the tail, and adjoining parts of the rump, are white in summer; but the rump and upper parts of the tail partake of the colours of the upper parts of the body in winter. The lower parts of the limbs are light grey, the same also prevails irregularly round the eyes, and corners of the mouth and nose, and lengthy tufts of light grey hair cover the inner surface of the ears.

Of the habits all we know is communicated by Capt. Eld, page 415, of the second volume of this Journal. It is only found, says Capt. Eld, in the valley of Moneypore, and has not yet been seen either in Cachar or in the Kubo valley. This information is confirmed by the testimony of Capt. Guthrie; but Mr. Inglis, as already stated, seems to have been aware of its existence in the Kasyah hills, but in what part, or at what elevation, or whether he saw it himself, or merely referred to a knowledge of its existence in these hills on the part of the natives, I am unable at present to say.

So much of the foregoing description as relates to the character of the species, has been drawn up without reference to the observations of Captain Eld, on the living animal. The hair about the neck, Captain Eld describes, in the cold weather as very thick and shaggy, like a horse's mane, and when suddenly roused in their native haunts, the whole contour is so commanding and formidable, that the boldest elephants refuse to approach them, and the commanding effect of their presence is increased in the winter by the strong smell which at this season proceeds from their bodies, perceptible at forty yards distance. In June, he remarks, they commence shedding their horns, and changing their coats of thick shaggy hair for a light glossy summer chesnut coat, in which their beautiful symmetry is admirably displayed. The new horns attain their full size by the end of November, but are not in full perfection until February or March. Such is the description of the animal, by one who was familiar with it in its native forests.

In concluding this imperfect account of a highly interesting species, I may remark that the materials placed at my disposal by Captain Guthrie, deserve a fuller and more perfect description than is here given; but as the numerous skeletons and skins which he has liberally procured are to be forwarded to Europe, more complete accounts of the animal may, and no doubt will, there be drawn up. The figure (plate xiii.) has been constructed from several skins, and the form of the horns in individuals of different ages, from the young to the adult, (plate xiv.) have also been drawn from the abundant materials supplied by Captain Guthrie. I cannot however conclude these remarks without expressing a hope that the very anxious solicitude of the Zoological Society, and the desire of its President, the Earl of Derby, to possess live specimens for the Society's Gardens in Regent's Park, as well as for his Lordship's unrivalled private collection at Knowsley, will induce Capt. Gordon, the British Resident at Moneypore, to exercise his influence with the view of obtaining a few living individuals for transmission to England.

The cold season would be that in which the attempt should be made, and the animals should arrive in Calcutta by the middle of January, so as to have them shipped early in February.

Description of Plate xiv.

Fig. 1. The horn of *Cervus frontalis*, about the third or fourth year.

Fig. 2. The same, about the fourth or fifth year.

Fig. 3. The same, the fifth or sixth year.

Fig. 4. The same, the seventh or eighth year.

The Benturong or Ictides Ater. DE BLAIN.

An interesting addition to the Catalogue of Mammalia of Assam, published in our last number, p. 265, has been made in the discovery of the *Benturong*, or *Ictides Ater* of Blainville, in that province, a living specimen of which, taken in the vicinity of Goalpara, being now before us. This animal has been brought to Calcutta by Mr. J. F. Delanougerede, a gentleman to whom we are indebted for a small collection of select specimens of Fishes for the Museum at the India House. The *Benturong* was first discovered in Java, but the first notice of its existence on the continent of India, will be found in the second volume of this Journal, p. 457, in noticing collections received from Captain McLeod, Special Assistant to the Commissioner of the Tenasserim Provinces, where the animal seems to be known as the *Myouk-Kya*, or Monkey Tiger.

The discovery now made of its existence in Assam, is another proof of the Malayan character of the Fauna of that country, and makes the number of the Mammalia already known to belong to Assam, 68; of these 67 are enumerated in Mr. Walker's Catalogue already alluded to. The specimen is a young male about 20 inches in length, exclusive of the tail. It is perfectly docile and tame, passing in and out of its cage and climbing up the arm, when extended to it. Its movements are peculiarly gentle and graceful, often standing erect on the hind feet, and generally using the tail as a support, twining it round some adjoining object. Its manners are playful, like those of the Bear, affecting to bite and use its claws. Its food consists of plantains, bread and milk, and raw meat. It has vertical pupils and appears to sleep much during the day, becoming more lively at night.

The Baraiya, or Cervus elaphoides, HODGSON.

We were favoured with an interesting letter sometime since from R. W. G. Frith, Esq., of Islampore, detailing the results of a highly successful shooting party in the Rungpore district, at the foot of the Garrow hills in April last, when amongst the animals killed on the occasion, there was a buck such as none of the party had before seen, and which Mr. Frith supposed might possibly be the *Cervus frontalis,* then only known from the imperfect notices of it in the two first volumes of the Calcutta Journal of Natural History. Since then, Mr. Frith has favoured us with a sketch of the head, which proves to be that of the *Baraiya,* or *Cervus elaphoides* of Mr. Hodgson. Mr. Frith at the same time, forwarded a sketch of the head of a young buck entering on his third year, which he thinks is probably the same species as the large one which was killed. Of this there can be no doubt, the horns of the third year being sufficiently characteristic; the horns or *dagues* of the second year, were slightly bent conical daggers of about seven inches long, which he shed in April, when about $2\frac{3}{4}$ years of age, by striking them against a post. In three months, the horns of the third year presented the characteristic form of the species, though not so fully developed as in the adult. The colour also changed from the bright yellow to brown intermixed with yellow; about the muzzle, neck and legs, dark brown. The one that was shot was anything but wild, Mr. Frith remarks, trotting away before the elephants like a horse. We might repeat the same injunction to Mr. Frith, as we have made to Capt. Gordon, relative to live specimens of this species for the Earl of Derby, and the Zoological Society.

Correspondence.

Vegetable Physiology.—Action of Metallic Poisonous Substances upon Vegetation. Communicated by E. T. Downes, Esq.

In certain localities it is the practice to spread upon the soil metallic poisons, such for example as arsenious acid, for the purpose of destroying insects. These proceedings, so likely to excite the fear of the public, seem worthy of being submitted for the opinion of some learned Society.

The Academy of Brussels has taken the initiative in bringing this question forward; two memoirs have been presented; we intend giving an analysis of these works.

We will not attempt here to recall to mind all that has been written upon the question which now engages our attention. Sufficient for us to say, that the views of the illustrious historian of the Alps, Theodore de Saussure, have been fully confirmed. "The roots of plants," he writes, "are filters of too fine a form to absorb any substances that are not fluid. If they admit solids, it is necessary that they should be so attenuated, so divided, that their diffusion in the liquid has all the characters of a true solution."

In a note presented last year to the Academy of Brussels, M. de Hemptinne declared, that having submitted to the ordinary processes of analysis, the various parts of carrots, potatoes, oats, and wheat, which he had sown and cultivated upon land, on which he had strewed 250 grammes* of arsenious acid to the square metre,† he could not discover the least trace of arsenic. All the vegetables were well-grown, and arrived at maturity, without having presented any thing particular during their growth.

The results of the experiments of the Royal Academy of Brussels are confirmed, as will be seen by the account which we now give.

The author of the first memoir, M. Louyet, Professor of Chemistry, at the Central School of Brussels, has impregnated the soil with

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* Gramme, 15.444 grains.

† Metre, 49.371 inches.

different poisonous substances. Having spread 256 grains of arsenious acid upon a bed of earth of 64 feet of surface, the germination, as well as the maturation of the seed went on as usual, without the possibility of discovering a trace of arsenic in the plants submitted to the experiment.

If the soil is charged with too great a quantity of arsenious acid, if it contains 1,200 grains upon the same space of ground, the seeds merely commence the germinating process. They then contain a sensible quantity of arsenious acid. In the same way, the author has seen plants perish after some days, which had been watered with a strong solution of corrosive sublimate. Analysis demonstrated, that they contained mercury. The author having impregnated the soil successively with arseniate of potash, arsenic, acid, tartrate of potash, and antimony, the plants grew, but in one of the experiments, the arseniate had become almost entirely insoluble in the soil; without doubt it had been converted into arseniate of lime by the reaction of the carbonate of lime upon the arseniate of potash ; the antimonial salt in another experiment became almost completely insoluble.

The same resulted in the moderate employment of acetate of lead, sulphate of zinc, proto-nitrate of mercury, and bichloride of mercury, without doubt for the same reason.

In a soil impregnated with sulphate of iron, the plants indicated more iron than those raised in a normal soil. In the same way copper has been met with in those which had been sown in earth charged with sulphate of copper, whilst a comparative study has not discovered a trace amongst the vegetables grown naturally.

This experience agrees with those tried by other learned men, from which it results that the coppery or ferruginous matters can penetrate into the plant, whether in the state of carbonate dissolved in water charged with carbonic acid, or whether in a state of oxide dissolved by the assistance of certain elements of the earth.

In examining with care these different experiments, they authorise the conclusion, that poisonous metallic compounds are not absorbed by plants unless in a condition to become soluble; that when they are absorbed, germination is found to be suspended.

That metallic compounds not poisonous, such as iron, appear to be more easily absorbed than others, although the sulphate of iron which was used in the experiment is also decomposed in the soil, and there becomes generally insoluble.

In a word, poisonous metallic substances may be mixed with the soil before sowing, without any fear that the plants which will germinate and vegetate in the soil containing any sensible quantity.

This conclusion will be found conformable to that of M. de Hemptinne. The author of the second notice, M. Verver, candidate at the University of Groningue, has mixed with the soil, in various proportions, arsenious acid, bi-arsenite of potash, and sulphate of copper, and afterwards several sorts of farinaceous seeds were sown in the ground thus prepared. He observed, as the preceding author had, that a too great proportion of arsenious acid prevented germination; that in the opposite case it took place without obstacles, and that the plants offered no traces of the poisonous substances.

The same resulted from the use of the bi-arsenite of potash.

The sulphate of copper had no effect in preventing germination, a fact conformable to the experience of the preceding author.

M. Verver in fact discovered that the salt became insoluble, without doubt from the decomposing influence of the carbonate of lime, in opposition to M. Louyet; that observer not being able to discover in that case any traces of copper in the vegetables submitted to experiment.

Little balls of arsenious acid and meal did not prevent vegetation.

The plants submitted to experiment presented no traces. It was the same when the bi-arsenite of potash in powder, or arsenious acid placed at the root, when young, or of cresses in full vegetation. All these experiments are confirmative, as will be seen, of the preceding ones. Other results were produced when the plants were watered with an arsenical solution. A polygonum orientale in full flower having been watered with a solution of bi-arsenite of potash, perished in twenty-four hours, and the author succeeded in discovering clearly the presence of arsenic not only in the leaves and stalks, but also in the seeds of the vegetable. It appears then that metallic poisons can penetrate into the seeds of vegetables, at least under circumstances, of which it was at one time doubtful.

The author has observed, that solutions of metallic salts, which have the property of being decomposed and rendered insoluble by the soil, such as sulphate of copper, acetate of lead, &c. cannot be made to penetrate the vegetables by means of watering.

If entire vegetables are plunged with their roots into dissolved metallic compounds, these compounds penetrate into all parts of the plants.

It appears then right, after these experiments, as well as the preceding ones, to admit, that there is no danger to the public health as regards the practice followed by many cultivators.

Nevertheless, these experiments are far from being absolutely decisive, and their negative results ought not to be admitted without restriction.

The analytical processes, employed by M. Louyet, are not such as ought to be entirely relied upon. This memoir, says the reporter, M. Martens, is not explicit as regards the analytical methods, by the aid of which the author has discovered the presence of foreign substances in the plants. In fact, he has not employed the method of carbonizing the plant by means of pure nitric acid; but after allowing the plants to macerate for two or three days, in a solution of caustic potash, he introduced the different solutions into Marsh's apparatus, after having concentrated and neutralised them by sulphuric acid. The author of the second paper, carbonized the various parts of plants which grew in the poisoned ground, by means of nitric acid, but he does not appear to have got rid of the residue of the carbonisation of the plants, previous to the introduction into Marsh's apparatus. The learned M. Martens remarks, upon the necessity of neutralizing the nitric acid by pure potash, then to displace it by pure sulphuric acid; for it is well known that the presence of nitric acid in Marsh's apparatus would interfere with the disengagement of the arseniuret of hydrogen, which is quickly oxidized or decomposed under the influence of this acid. We insist upon these points, because we believe with M. Hemptinne, that it cannot be too boldly recommended to practitioners, to banish from the operations of agricultural industry, as well as from manufactories, the use of this dangerous poison. M. Martens wishing to verify the results of these two papers, watered different plants in pots, such as a young orange tree, Cactus speciosus, and Pelargonum capitatum, with a strong solution of arsenious acid : at the end of eight or ten days, during which the watering had been continued, the plants perished. The analysis did not discover the least trait of arsenic in any part of the plants.

From this we may conclude, that arsenious acid employed in solution, is capable of destroying the plants without penetrating into their trunk.

Probably in this case the poison penetrates into the root, or into the radicular extremities of the plant, altering the functions or the organization, and thus produces the death of the vegetable.—*From L'echo du Monde Savant.*

Extract of a Letter from T. A. Henley, Esq., *dated Port Louis, Mauritius, 3rd April* 1842, *to* George James Gordon, Esq., *Calcutta.*[*]

Since I had the pleasure of forwarding you a box of samples of produce of this Island, by the *Exmouth,* favored by Mr. Bell, and got up as is often the case in like circumstances in a hurry; it occurred to me that I might have at some time excluded a specimen of much interest. I now endeavour to make up for the omission, in forwarding to you a sample of the Sugar Cane of the Island, thoroughly desiccated and powdered, so that you will have in Calcutta, in most complete preservation a portion of the Island Cane, minus its aqueous portion. I believe I took occasion in a former letter to notice to you, that previous to the researches of the French chemists, (at least previous to my knowing any thing about their operation,) I had been occupying myself in analysis of the Sugar Cane, and was so struck with the difference between the absolute contents of the Sugar Cane in saccharine matter, and that obtained by the ordinary process of manufacture, that some of my friends treated the thing as absurd, whilst others more reasonably, came accompanied by the specimen of Canes they desired to analyze, and

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[*] We are indebted for this communication, together with the following valuable note on the subject by Mr. G. J. Gordon, to the kindness of John Allan, Esq.—Ed.

"Probably exposing the cane-trash as it is called to a slow current of boiling water, might be sufficient to extract the saccharine matter retained by the woody fibre after the expression of the juice by the ordinary process. This would be far less expensive than the drying and grinding process, and would leave the cane-trash in a form still fit for fuel when dry."

waited personally to observe the result. Soon after this, I learnt that similar researches had been made by Peligot in France, who struck also with the great difference in the yield of Cane scientifically treated, and by the ordinary colonial processes, had aided in getting up a company for the exportation of Cane, with permission from the French Government to introduce into France, free from duty, eight millions of pounds of dried Cane. The difference of produce may be estimated by the fact, that our Island Sugar Cane contains from sixteen to twenty-two per cent. of sugar and syrup, whilst by the ordinary methods of manufacture, from eight to twelve are the limits. Peligot in his analysis gives eighteen per cent. of *bonâ fide* crystallizable sugar as the contents of the Cane, with ten to twelve per cent. of woody matter; and states, that the Cane juice is a simple solution of sugar and water, and is *altogether crystallizable.* This latter observation does not coincide with my repeated researches. But there can be no doubt, that there is less uncrystallizable sugar in any given quantity of Cane, treated by the dry process, than when treated in the ordinary method. The violent crushing action of our Cane mills, by creating a great exposure to atmospheric oxygen, evidently occasions some change in the relations of the elements of the Cane, and the trifling difference which exists between gum, sugar, starch, &c., will afford some insight into the causes of the change which does actually take place; for the quantity of molasses or uncrystallizable sugar is very much greater, than when the saccharine matter is properly extracted without crushing the Cane. Our Island process gives from 100 parts or pounds of Cane, fifty to sixty lbs. of Cane juice, forty to fifty of trash, whereas this latter should be but ten or twelve. The difference being the loss, besides a larger portion rendered uncrystallizable. The drying method may be applied to any extent of operations, and some questions arise affording subject for reflection, such as the dried and powdered Cane being compressible into bales might be sent home, and run directly through the superior processes of the European refiners; or, as it contains more than half its weight of sugar, why might not the poor employ it directly. A portion placed in a bit of open muslin, and put in a cup of tea, yields its sugar instantly to the fluid, without any foreign or ill flavor whatever. If you will take a portion of the dry Cane I now send you, and pour it lightly into a $\frac{3}{4}$ inch glass tube, say six or eight inches deep; on pouring a little cold water over it, clear syrup will run through by the method of displacement, until nothing but water comes off; by pouring the latter syrup in a fresh portion, a concentrated syrup will be obtained. This is the method to employ on the large scale, operating on tons at a time. It is remarkable that the native manufacturers obtain more saccharine matter from their Canes in the relation of twenty to fourteen, as I have found at Barripore and Benares, &c. &c. than the best European steam mills. The natives water their Cane trash, but the tedium of the process decomposes the subject, and in some instances in short nullifies the advantage they gain. The method of drying the Cane for manufacture is peculiarly applicable to Bengal; for I found in Benares, Azeemghur, Gauzeepore, &c. that the *small hard* country Cane only yields $\frac{1}{3}$rd of its weight in Cane juice, the refuse $\frac{2}{3}$ds, containing locked up a very large proportion of valuable matter, which cannot be touched by the very best steam mill. In fact, no crushing process can extract the juice completely, even from the more tender Canes of this Island. I frequently amuse myself in making sugar from the trash coming from a good ten-horse mill, as a proof, by synthesis, of the improved method. I think the drying process one of great interest to Bengal, and one which might lead to very important results.

" Trais produits principaux qui constituent la Canne."

Eau........	72.1
Sucre......	18.0
Ligneux....	9.9
	100.0

Extract of a Letter from S. H. Robinson, Esq., *dated Dhobah, August* 22*d*, 1842, *on the Dhobah Coal Mines on the Adji.*

As I promised you, I now enclose a section of the strata at Choukeedanga Colliery in the Burdwan district, of which you are welcome to make any use you please. The situation is, I think, about four mile S. W. of Serapore Ghat on the Adji river, and rather less N. W. of the dâk station, Mungelpore, on the great Benares Road.

The great similarity between these beds, and those at Rannygunge Colliery, as described by Mr. Jones, is remarkable; and should you consider this worth publishing, as the accumulation of such facts would tend to throw great light on the true character of these deposits, I am in hopes the example I have set may be the means of inducing others, who have experimented in the same field, to contribute the results of their experience also towards the general fund of information.

I remain, yours truly,
S. H. Robinson.

Section of Strata at Chowkeedanga Colliery.

Feet.	Inch.	
12	0	Sandy soil mixed with kunkur.
6	0	Very soft brown sandstone.
1	0	Very hard ditto ditto, (called "live stone" by the natives).
4	0	Very soft ditto ditto.
8	0	Tolerably hard ditto ditto.
10	0	White sandstone, intersected by dark brown veins.
5	0	Shale.
5	0	1st Coal bed, inferior quality.
0	2	Shale.
5	0	2nd Coal bed.
0	9	Shale.
5	0	3rd Coal bed.
7	0	White sandstone.
2	0	4th Coal bed.
Total 70	11*	

To the Editor of the Calcutta Journal of Natural History.

Dear Sir,

We too frequently refrain from seeking interesting, if not useful information, from those who are alone able to impart it, from a natural, but I think censurable, reluctance to expose our own ignorance, or otherwise from a fear that our enquiries may prove to refer to objects either too trifling to merit attention, or too common to be unknown to any soul, with eyes and common sense, but our own individual selves.

Under this fear, we frequently lose both interesting and useful information, and that in many instances, from those who might casually add to their own *knowledge* whilst removing a portion of our *ignorance.*

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* To render sections of this nature complete, the dip, the joinings, the mineral, economic, and the organic characters of each bed should be noticed in full detail, for every bed has its own peculiar characters by which it may be distinguished and recognised wherever it be met with, and under whatever form of metamorphoses it may occur. Excellent examples of the method of describing rocks, and distinguishing them by means of their fossil contents, etc. will be found in our notices of Mr. Murchison's work, contained in former Nos. of this Journal.—Ed.

These remarks apply in particular to the Natural History of this country, which appears to be but imperfectly known, even to those from whom we have some right to expect more than ordinary or common-place information. Take for example, the Anglo-Hindoostanee lexicographer, (Mr. Shakspear,) who gives such definitions as the following:—*(Thompson's Oordoo Dictionary on the basis of Shakspear's.)*

Bunsee-but—name of a plant.
Buz'a—name of a bird.
By'la—a species of bird.
Bhung'ua—a kind of fish.
Geuth—name of a fish.
Gohoonuh—a kind of snake.

Definitions like these, (and there are numerous others, though, no doubt, the best that the author could give,) are little calculated to enlighten those who, like myself, having no scientific knowledge or scientific works of reference on the Natural History of this country, are unable to recognize the name or class of any object which may fall under their notice, though familiar with the *native* name, if *that*, through the medium of a more *communicative* Dictionary, could but be identified with its correct English synonyme.

If, however, your excellent Journal be open to the correspondence of enquirers like myself, the defects to which I have adverted will very speedily be corrected, and the Natural History of India be no longer, as it now is, a mystery to the unlearned.* Information may be sought regarding the names, habits, &c. of the birds, beasts, fishes, insects, and reptiles, of the land in which we live, and the information so sought may be in your power, or that of some one of your contributors to furnish; thus not merely gratifying the enquirer, but also a very large class of your readers.

To illustrate one means through which information may be elicited, I beg to forward and place at your disposal, with this letter, a bottle containing two snakes, and an insect bearing some resemblance to a large cockroach.

The lower of the two snakes was caught some days ago, and killed by immersion in hot water. The servants here say, that its native name is "Chittee." Dr. Russell, in his continuation of "Indian Serpents," describes a Coluber, (No. 4,) and illustrates it with a coloured

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* The Journal of Natural History is intended for such communications as the one now inserted from our excellent correspondent, from whom we hope to hear often. The serpents presented, are *Coluber Nooni Paragoodoo*, Russ. No. 21, which seems to be called Chittee in Bengal, a name which in Madras is bestowed on quite a different species. The other two specimens are the *Wanna Pam* of Russell, or *Coluber Stolatus*, Lin. The Naowur is as suggested by our correspondent, the *Nepa grandis* of Hutton, or large water Scorpion; the other insect is a locust.—Ed.

figure, which, however bears little resemblance to the snake now sent, though Dr. R. quotes the same native name. Allowance must be made for the change in colour to which scalding water most probably subjected the present specimen, but it were safer nevertheless to enquire at some further period, on better data, whether the "Chittee" of Bengal be identical with the "Chittee" described and figured by Dr. Russell, a question which certainly merits attention.

The upper and brighter coloured snake was caught at noon yesterday morning, and after being disabled by a blow on the body, was finally killed by immersion in spirits. The native name of this snake is "Hulhulliya," of which I am fortunately able to send a second *living* specimen, in a separate bottle, caught a few minutes after the one in spirits, and on the same spot; both, most probably, members of the same family. Pray are these two snakes identical with the Wanna-pam and Waunacogle of Coromandel, or Kurharrid described by Dr. Russell?

The insect was caught one night at Alleepoor in Sept. 1840, having flown into the room apparently attracted by the table lights. The servants stated that its native name was "Naowur," and that it was common to the banks of ponds. A friend believes this insect to be identical with the *Water-scorpion*, (Nepa grandis,) described by Lieut. Hutton in the Asiatic Society's Journal for Oct. 1832. Pray is it so?

The covered glass contains another curious insect, which flew into the room night before last; I suppose like the other, enticed by the lights on the table. Its native name I can't learn, nor can the servants give me any information regarding it. Pray can you?

If these objects be rare and little known, your possession of them will enable your artist to give coloured figures, which with descriptions, would be alike interesting to many of your readers, and

Yours faithfully,

Alleepoor, Sept. 6, 1842. TULUBGAR.

P.S.—I take the same opportunity of forwarding living specimens of an insect that abounds here on the flowers of the *Dherus*, or eatable Hibiscus, of which it is a sad destroyer. If all these should prove to be common-place, and too well known to merit attention, pray pardon the trouble to which my acknowledged ignorance may have subjected you.*

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* The living insects here alluded to by our Correspondent are the most valuable species of Blistering fly, *Mylabris chicorii*, which, to within the last few months has been imported to

Barren Island in the Bay of Bengal.

The last account of Barren Island was communicated by the late Dr. J. Adam, about ten years since, to Prinsep's Journal of the Asiatic Society, Vol. I, Page 128. The account in question appears to have been drawn up from the statement of a friend, from whom Dr. Adam received certain specimens of the rock of the Island. As nothing can be more curious and interesting than to compare the condition of active volcanic operations at different periods, we have great pleasure in submitting the following remarks to the reader, as we committed them to paper from the verbal statement of Capt. Miller of the Bark *Lady Clifford,* who in April last visited the Island about 8 A. M., and remained on it till 11 A. M.

Capt. Miller thinks Barren Island is about 6 miles in circumference, presenting a bold rocky coast with very deep soundings, the colour of the water being ocean-blue, and 120 fathoms of line out, and no bottom close under the rock. The Island is of an oval shape, and towards the north-west extremity, there appears a flat elevation of about 500 feet. Passing round to the base of this by sea, a breach is observed in the coast of about 200 feet, occasioned by a stream of lava having burst from above, and run into the sea. Ascending this causeway, Capt. Miller, at a height of 30 feet, entered a spacious amphitheatre of a circular shape, enclosed by elevated sloping sides, partially covered with grass above at their margins, but below the rocks, were perfectly naked and of rich purple tints.

The extent of the amphitheatre is about ½ mile or ¾ of a mile in diameter, the sides perfectly circular, sloping upwards to a height of

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India from Europe, to the value of several thousand pounds sterling per annum, as a portion of the annual supplies of Medical Stores for the public service. Through the exertions of Dr. Angus and the present Medical Board, arrangements have recently been made, for obtaining supplies of the article from Cawnpore and Mysore, at a considerable saving to the Government; but the information as to the plants they frequent, and their existence in such abundance even in Calcutta, is new and important. Let us recommend to our worthy Correspondent, to whom we are indebted for a knowledge of these facts, to extend, if necessary, the growth of the *Dherus,* or eatable Hibiscus, and collect these insects in quantity for the use of the public service, and for exportation: we will answer for the profitable results of such an undertaking. The insect should be collected by means of gauze nets, and then immersed in turpentine, and afterwards dried and packed. The ordinary supplies from Cawnpore are liable to be attacked with worms, probably from the insect being immersed in scalding water, instead of turpentine, as we believe is generally directed to be used for the purpose.—ED.

about 500 feet. In the centre of this immense area, a circular cone ascends to a somewhat greater height than that of the sides. This inner cone is perfectly symmetrical, and of a very abrupt angle, at least forty-five degrees; its base occupying about a quarter of a mile, or a little more, leaving an uniform open circular space of perhaps 200 yards broad all round its base.

From the summit of this cone, Capt. Miller saw a clear and full stream of transparent vapour issue. So transparent, that it was not perceptible from the sea, nor until he entered the amphitheatre; this vapour is the only indication of the present activity of the volcano; but old streams of lava are seen on the side of the cone, specimens of which Capt. Miller brought away with him; these lava streams are the same material as the cone itself; they are also identical with the causeway, or burst of lava forming the breach leading down to the sea.*

There is no vegetation of any kind within the amphitheatre, but a few small trees are found on other parts of the Island, which however barren it may have been at one time, is now well wooded.

Capt. Miller describes the view of the inner amphitheatre as magnificent beyond all description, with the gigantic pyramid rising out of the centre to an elevation of 500 feet. Ascending this to about one-third of its height, Capt. Miller found it so steep and difficult, that he was obliged to return. It consists of hard, porous, or loose granular kind of lava of blackish brown colour, with whitish grains of felspar about the size of duck shot imbedded the matrix. Decomposing by the action of the air, the little grains become detached, and falling down the surface of the cone, fill all its crevices and hollows, giving to it the peculiar smooth and symmetrical form which it presents to the view. The outer walls of the crater forming the amphitheatre, are composed of the same material as the cone itself, but of a more solid character, and less subject to decomposition. The causeway or inclined plane, upon which the ascent is made through the breach at the only accessible point, consists of the same material as the cone itself, but is more heavy and compact. It consists of dark blackish lava, with a slightly vitreous lustre, and greyish pearly grains of felspar imbedded in it. This also constitutes the general mass of rocks composing the island.

To afford an idea of the value of his remarks, and the opportunity he

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* It will be recollected, that at the period to which Dr. Adam's account refers, this mass of rock was quite hot, so as to communicate an almost boiling temperature to the adjoining sea water.

has had of making observations, Capt. Miller wishes it to be understood that he merely ascended the causeway or breach in the side of the amphitheatre communicating with the sea, and then ascended about one-third of the inner cone; unable to get higher, he returned, and next tried to ascend the sides of the amphitheatre, and after climbing half way, was unable to proceed further.

Capt. Miller has also brought away the seeds of a plant growing on a patch of grass near the causeway, on the margin of the sea, in the curious form of a tent, the stem ascending in the middle, and the leaves falling on every side externally, so as to form a perfect enclosure or shelter within. These seeds are to be sent to Dr. Voigt for the Botanical Garden. J. M.

Miscellaneous.

The Annals of Electricity, Magnetism, and Chemistry; and Guardian of Experimental Science. On the Chemical Relations now subsisting between Plants and Animals, with reference to those which have subsisted in former ages. In a Lecture delivered at the Conversazione, on Wednesday, March 9th, 1842. By Dr. LYON PLAYFAIR, *Royal Victoria Gallery, Manchester.*[*]

It is not an idle task to cast a retrospective glance to ages far beyond human ken, or to try to discover the physical and chemical causes which then regulated the production and maintenance of animal and vegetable life. Races of animated beings once lived and performed their destined functions on the earth, but have now passed away for ever. Ages rolled on, and other races were called into being, which have again disappeared, and yielded their places

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[*] We admire the freedom and success with which the laws of Chemistry are brought to bear, in the elucidation of organic life in the early conditions of our planet, in this paper. We never before recollect to have seen the subject treated in so much detail; it is at least one of the first attempts to reconcile the laws of chemistry with the progression of organic life, or rather to reconcile the various phases which the latter has assumed, with the chemical conditions of the atmosphere during the early ages of the earth; and the ease with which the progressive development of an atmosphere, suited to the existence of the higher classes of animals, is traced from physical causes in this paper, evinces a philosophical spirit of high promise in the author.—*Ed. Cal. Jour. Nat. Hist.*

to new forms of organic life. Geologists have examined their remains, and endeavoured to form conceptions of the physical characters of the globe during their residence on it. They have drawn legitimate conclusions, from the order of their occurrence, regarding several grand eras in the history of the world. These inferences have been deduced from external characters possessed by animals and plants occurring in particular formations; and, by a happy application of analogical reasoning, they have shewn what must have been the aspect of the face of nature when these plants and animals existed. Why, therefore, should the chemist be afraid to follow in their footsteps; and by evidences drawn from the chemical composition of matter, lend his aid in explaining the mighty revolutions which have taken place upon the surface of the earth? True, his science is not speculative, nor does he love to waste his time in the vagaries of theoretical speculation; but, we believe, that the evidences existing on the earth are sufficient to form a basis for inductive reasoning, without the necessity of substituting ideas for facts.

I shall, therefore, endeavour to lay before you this evening an account of some of the chemical causes which have led to the development of the various races of animals and vegetables, which have appeared and disappeared in their course. And be it remarked at the threshold of our enquiry, that by the term *chemical* causes, we do not at all mean to undervalue the *physical* causes which have lent their aid or been paramount, in their development or extinction, but merely employ the term to form a boundary in the examination of a boundless subject.

But, before I can make myself understood, it is absolutely necessary that you should be acquainted with the laws which regulate the nutrition of the vegetables now existing on the earth. Mr. Ransome, in a series of lectures, has so ably performed this task, that little remains for me, except to refresh your memory with a few of the grand laws connected with vegetable nutrition. You are all aware that organic matter, in general, is composed of four substances, carbon or charcoal, oxygen, hydrogen, and nitrogen. You know, that when charcoal unites with oxygen, it forms a gas familiar to you as the air which escapes in small bubbles from champagne or beer, and which has received the name of carbonic acid gas. You know also that when oxygen unites with hydrogen, the familiar substance, water, is produced; and that when the latter element (hydrogen) enters into union with nitrogen, ammonia or hartshorn is the product.

Now, these three compounds—carbonic acid, water, and ammonia—form the food of plants. They all exist in the air, from whence they are extracted by the vegetation which covers the earth. The grand difference between animal and vegetable life is, that this carbonic acid, which is fatal to animals, is the primary food of plants; and that whilst plants are continually inspiring this noxious gas, animals are as constantly expiring it. There are certain constituents in the food of man and animals, which are not at all calculated to assist in the nourishment of the body, but which are, nevertheless, indispensable in supporting the process of respiration. Such are starch, sugar, and gum. I had the honour, on a former occasion, of explaining this to you in detail. These substances, in supporting respiration, are converted into carbonic acid and water. Hence it is that animals continually expire this gas. But there are other substances also exclusively adapted for the nutrition of the system, and which, when present in superabundance, are separated as excrementitious matter. In such substances nitrogen abounds. Hence during their decay, ammonia is generated. When animals die, their bodies enter into a state of putrefaction, or, to speak more correctly, the constituents of which their bodies are composed, change their form, and are converted into carbonic acid and ammonia.

Conceive the thousand millions of men who inhabit the globe, and the myriads of animals which teem on its surface—all sending into the air, every day, vast quantities of that noxious gas. Conceive the vast amount of fuel constantly generating the same compound, and it is obvious that the earth would soon become uninhabitable were there no means of removing it from the atmosphere. Nor is this all. As carbonic acid is fatal to animal life, in as great a degree is the oxygen of the air necessary for its support. But this oxygen is always withdrawn from the air as carbonic acid is formed; for carbonic acid consists of carbon and oxygen. Thus, in burning, ten cwt. of coal consumes 32,000 cubic feet of oxygen gas; so that this town of Manchester (calculating its inhabitants at 300,000, the round number of the former census) consumes, for domestic purposes alone, exclusive of the manufactories, no less than 23,614,285,714* cubic feet of oxygen, and sends into the air a like quantity of pestiferous carbonic acid in its stead. Again, each man

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* The calculation is as follows:—It has been found that a small town of 7000 inhabitants consumes in fuel, for domestic purposes, 551 million cubic feet of oxygen.

$$\frac{551{,}000{,}000 + 3000{,}000}{7000} = 23{,}614{,}285{,}714$$

consumes and corrupts, every day, twenty cubic feet of air; hence the population of Manchester, by the air consumed in breathing, corrupts 2,190,000,000* cubic feet of air every year.

But vast as these quantities may appear, let us consider what a fraction of the globe we form; and not to extend our ideas beyond what they will readily embrace; let us calculate what 100 million men (an insignificant portion of the population of the globe) will annually consume and corrupt of air.

One hundred million men, then, will render unfit for the support of animal life, every year, no less than 9,505,200,000,000 of cubic feet of air.

From such data as these, it is evident, that the air would soon be rendered unfit for the support of animal life were there no means by which it is retained in a state of purity.

This it is the duty of plants to perform. An Allwise Creator has connected the life of plants and animals most closely together, the one depending upon the other. It is, indeed, a wonderful link which associates the vegetable and animal kingdoms. Plants form the primary nutriment of all animals; for although there are certain kinds entirely carnivorous, still the herbivorous animals upon which they subsist receive their nourishment from vegetable matter. But, following the chain in its continuation, we discover that animals, on the other hand, furnish the food of plants. During their life, they constantly expire carbonic acid, and discharge from their system matter, which by its decomposition, emits ammonia into the atmosphere; whilst at their death, their bodies decay, and furnish the same substance to the surrounding air. Thus they afford food for those very plants, upon which they themselves subsist; thus also the destruction of an existing generation forms the means for the production of a new one, and *death* becomes the source of *life.*

Such is a brief outline of the intimate connection subsisting between the animal and vegetable kingdoms. So closely, indeed, are they bound together, that, in the present system of things, we could not conceive the existence of one without that of the other.

But very different seems to have been the arrangements which prevailed in former ages. Animals were not then created in number sufficient to supply the food of plants. And although we cannot affirm, or even suppose, that the animal kingdom was independent

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* The calculation is as follows:—Supposing that a man consumes 20 cubic feet of oxygen, each day, in the process of respiration, then 365 + 20=7000. Again, 7300 + 300,000=2,190,000,000.

of the vegetable, we have evidence enough to shew, that the latter was in no wise dependent for support upon the former. If it be allowed that the paucity of animal remains, even in the carboniferous strata, where plants so abound, proves that the balance betwixt animal and vegetable life now subsisting, was then unknown, we must suppose that the food of plants was then supplied from other sources.

It matters not what vague speculations have been held regarding the cosmogony of the world. With these the chemist has nothing to do. His science treats only of matter and its properties. Nor can he, without ample demonstration, listen to specious notions propounded of the transformation of the elements of which it is composed, or admit these as a basis for induction. His science teaches him that there are fifty-five bodies on the earth, by the different combinations of which all the varieties of matter are produced. And further, in the present state of his knowledge, he must allow that all these elements were on the globe when its present position was assigned to it.

However different in intensity and in form may have been the causes which produced the mighty yet gradual revolutions of former times, we discover in them a close analogy to those of the present day. Hence we are not warranted in presuming that the food of plants and animals was different then from what it is now. So far only can we affirm, that the food of plants was received from other sources than at present.

The food of plants consists of water, carbonic acid, and ammonia. What proofs can we find of the existence of these in former periods of the earth's history? During the depositions of the primary strata, where as yet no traces of plants and animals have been found, it is evident that carbonic acid existed. The primary limestones furnish sufficient evidence of its existence. It is true that the partial and irregular distribution of these limestones prove that their deposition was due to limited and local causes; but this does not militate against the idea that the carbonic acid must have been generally diffused throughout the atmosphere. All the limestones of aqueous origin have evidently been deposited from a solution in water containing an excess of carbonic acid; for without this excess, carbonate of lime will not dissolve. Now, without entering into geological speculation, it seems to be pretty conclusively established that the heat of the ocean was considerable during the deposition of the earlier of the primary strata. From the contortions in the laminæ of gneiss, mica schist, and chlorite schist, the water from whence they were deposited appears to have been in a very troubled state, just as it is in the present day when in a hot vessel. Now, when in this hot state it could not absorb or retain in solution carbonic acid from the air. Only in those spots where local causes had reduced the heat, carbonic acid might be dissolved and carbonate of lime formed; or, if pre-existing, brought into solution, and afterwards deposited. This heated state of the ocean might, in some degree, account for its saline impregnation. There is no evidence of land having existed during the primary period, and during the ages which constituted it, this heated water acting upon the rocks which formed the crust of the globe, would have a wonderful effect in promoting chemical combinations, and dissolving the various soluble materials contained in these rocks. In all strata of later origin than the primary, we find rock salt. Salt springs arise from the coal system:—Rock salt abounds in the new red sandstone. The Alpine salt works are in the oolitic system; those of Cardona in the greensand; and of Wieliczka in the tertiary rocks. (Phillips.) But, as far as I am aware, rock salt is absent from the primary strata. This seems to indicate that the water had not obtained its full saline impregnation when those strata were deposited. And indeed, it seems not improbable, that during this era, the water obtained many of its soluble salts from the disintegration of the primary rocks.

But to return from our digression. The existence of the limestones proves that even in the primary period, carbonic acid existed. The peculiar smell which distinguishes hornblende, and various aluminous minerals, when they are moistened, is due to minute traces of ammonia contained in them. Now this smell is very perceptibly possessed by the hornblende schists, and accompany gneiss; and hence we have a right to conclude, that they absorbed this compound from the air, or from the water, during their deposition. There are many facts to prove that ammonia was formerly of inorganic origin. Not only is it a constituent of all aluminous and ferruginous minerals, but it exists in many natural products found in volcanic regions. Dr. Daubeny has supposed that all the carbonic acid and ammonia which now exists, or has existed in the atmosphere, may have been derived from the interior of the earth. He finds a difficulty in conceiving how the hydrogen and nitrogen could have been made to unite on the surface of the globe, and hence, draws them from its interior. But although we do not agree as to the source from whence the food of plants is derived, we both equally admit that the primary food was of *inorganic* origin.

But I must assume, for the present, on the supposition that these bodies were original constituents of the atmosphere, that they both existed in the air, during the primary periods, or, at all events, antecedent to the secondary, in much larger quantity than they do now: and the proofs are obvious. Consider the immense deposits of vegetable matter in the carboniferous strata. All the carbon and nitrogen of which this is composed must have been originally present in the air as carbonic acid and ammonia. The greatest part of this vegetable matter is carbon; and hence it follows, that, as the carbon of the carbonic acid was retained, and its oxygen liberated, the air of the present day must be much poorer in carbonic acid, but much richer in oxygen, than that of former ages. Dr. Daubeny denies the possibility of ammonia ever having been present in the air in much larger quantity than at present; and, in proof of his view, he cites the experiments of Christison and Turner, that $\frac{1}{100}$ of ammoniacal gas in air acts as a poison to the vegetable kingdom. To this it may be replied, that ammoniacal gas is never present in the atmosphere. It is always in union with carbonic acid as carbonate of ammonia; and it is well known that water impregnated with this salt in the proportion of 30 : 1, is very beneficial to vegetation. One pound of rain water contains rather less than ¼ grain of carbonate of ammonia. Now, even supposing that the rain of former ages contained 800 times this quantity, it would not be prejudicial to plants, but administer to the luxuriance of vegetation. Again, it has been found that plants flourish with great luxuriance in an atmosphere containing as much as $\frac{1}{12}$ its bulk of carbonic acid. But the air of the present day contains only one volume of this gas in 2,000 volumes of air. Hence it follows, that the air of former ages may have contained more than 150 times this amount, without injury to vegetation. These facts are sufficient to prove that the air formerly may have been much richer in the food of plants. Brogniart believed this to be the case many years since, and founded upon this view some ingenious speculations. Doubtless an atmosphere with quantities such as we have mentioned, would prove fatal to animal life, but we will shortly shew that the express duty of former plants was to prepare the world for the reception of animals, and finally, for that of an intellectual being. One question, then, only remains: from whence did the atmosphere receive this carbonic acid? Dr. Daubeny conceives by a gradual evolution from the interior of the earth. He supposes that this carbonic acid was furnished to plants during their life—not that a certain amount was originally emitted into the great magazine of food—the atmosphere. But it is difficult to conceive that an Allwise Creator would have made the life of plants and animals dependent upon adventitious circumstances. And surely it cannot be averred that the emission of carbonic acid from volcanic sources, would be regulated by a direct interposition of a Divine Providence. The vegetation of the globe did not at once spring into existence, but was as slow in its progression, as that of animals; so that during the ages, when a scanty vegetation covered the earth, the cabonic acid must have been constantly accumulating. And if, at its commencement, there was sufficient carbonic acid for the wants of plants, in the course of ages it must have been accumulated in much larger quantities. So that even on this view we must admit, that the proportion in the air could not be kept in any constant quantity. But we do not see any strong reason to suppose that the original food of plants was evolved from the bowels of the earth; nor can we discover any strong objection to the hypothesis, that all the carbonic acid and ammonia from the beginning of time, were original constituents of the atmosphere. The nitrogen and oxygen of which the atmosphere consists were certainly not evolved from the interior of the earth; and yet upon the same grounds could this be affirmed, for nitrogen, like carbonic acid, is evolved from the volcanoes of the present day. It is indeed difficult to conceive from what stupendous magazines of carbon the carbonic acid of the air was formed, or how hydrogen became united with oxygen to form all the water which covers the earth, without the occurrence of such dreadful explosions as would dash the present system of the world to fragments. Such stupendous operations of nature are as yet beyond the capacity of the human mind to fathom: just so with the ammonia. If we cannot comprehend the mighty power which deprived its elements of their elastic condition, we can only believe that that power is as yet undiscovered.

From all that has preceded we believe we are warranted in considering that the carbonic acid and ammonia in the air were original constituents of the atmosphere; and further, that in former ages, they were present in much larger proportion than at the present time. We have shewn that such an atmosphere would not be unsuitable for vegetable life, although it would certainly prove destructive to terrestrial animals. We have now to examine the economy of vegetable animal life of former times.

The first certain proofs of organic life occur in the grauwacke series. It is certainly singular that animals occur in this series, where plants are not found. These animals are not merely zoophyta, but conchifera. Still we cannot suppose that sea-weed did not exist to supply them with food; for the spongy texture of such plants make them prone to decomposition. The paucity of animal remains at this period, and their very unequal distribution, indicate that the conditions necessary for the support of animal life were not yet generally established. As we reach the silurian rocks, we discover that the conditions for organic life have become more favourable, and consequently we find a much greater variety of forms; but we are still struck by the paucity of vegetable remains. Doubtless these were present in quantity sufficient to supply food to the marine animals which existed, but their perishable tissues have yielded to the elements of destruction, and disappeared. The upheaved land during the grauwacke and silurian systems seems to have been too limited to favour the production of terrestrial plants.

The disturbances which ensued after the close of the primary period, rendered the earth more adapted for vegetation. Land was upheaved, and the energetic causes then in operation must have materially assisted in effecting its disintegration. The time which elapsed between the close of the primary, and commencement of the secondary periods, would be employed in the formation of soils on this upheaved land. Soils formed from the detritus of the primary rocks would be eminently adapted for a luxuriant vegetation, such as existed during the deposition of the carboniferous strata.

But no means of removing the excess of carbonic acid of the air having been yet in operation, terrestrial plants could not be accompanied by terrestrial animals. It is obvious that this excess of carbonic acid could not be very detrimental to the life of marine animals; because the sea, saturated as it is with salts, can only hold a certain quantity in solution. But still the sea also must have contained considerably more of this gas then, than at the present day. The scantiness of vegetation was the great characteristic of the primary strata; but in the coal systems, this vegetation is marvellous in its extent. The principal deposits in the series are arenaceous, argillaceous, and calcareous. The calcareous deposits of the primary period, even as high as the upper silurians, occur in detached masses, forming no continuous beds, like the carboniferous, or mountain limestone. We find a total absence of land reliquiæ in these calcareous beds. Add to this, that, besides the nature of their fossil remains, they afford evidences of a very tranquil and gradual deposition; and it is apparent they must be of a marine origin. The excess of carbonic acid dissolved by the water from the atmosphere, would render the sea capable of retaining a large quantity of carbonate of lime in solution.

And the luxuriant vegetation which covered the sea as well as the land, would constantly be abstracting this carbonic acid for the purposes of food, from the surrounding water. The carbonate of lime being thus rendered insoluble, would, be tranquilly deposited. And thus two substances being removed, which in excess are fatal to certain animals, other forms of organic life would spring into being. Here, then, we are furnished with an explanation why the limestone does not occur in continuous beds in former strata; for however great the quantity of limestone in solution might have been, it could not have been deposited, were there no means of removing the carbonic acid which retained it in solution. Only in particular localities, where adventitious circumstances occasioned the expulsion of carbonic acid, the limestone would be deposited.

And now we come to the consideration of those vast deposits of coal which form such striking monuments of a primeval vegetation. The entire coal series often attains a thickness of 1,000 yards; the beds of coal occurring in it are occasionally three or four feet thick, and not unfrequently several yards. The thickness of all the coal beds taken together may average forty or fifty feet in the English and Scotch coal fields. Now when we consider the vast area covered by the coal series, we must feel convinced that during its formation, peculiar causes were in operation, which occasioned a great luxuriance in vegetation. It is true that such rivers as the Oronoko and Mississippi roll down to the ocean vast quantities of vegetable matter; but great as these are, they do not even furnish us with a faint conception of the manner in which the great carboniferous deposits have been formed. The wonderful luxuriance of vegetation during the carboniferous era is doubtless attributable to the amount of carbonic acid in the air. The remains of plants which constitute the various seams of coal, shew that they were principally terrestrial. Many of these beds of coal appear to have been formed of drift vegetation; but others shew every evidence of the plants having lived and died on the spot. This is the case with the North of England coal field; and most of the North American coal fields shew similar evidences; the Devonshire coal fields, or culm measures are, on the other hand, I believe, frequently composed of drift matter.

Now in these coal fields which shew evidences of having been formed *in situ*, a bed of fire clay is almost invariably found immediately below the coal. In this are present large quantities of stems and leaves of stigmaria, ficoides, &c. The constant occurrence of this underclay, evidently indicates some general cause. Now, when we examine the composition of the ashes of coal, and that of the fire clay, we discover the same ingredients in both. Potash, and magnesia are contained in the fire clay, and from their constant presence in coal appear to have been indispensable to the development of the plants constituting it.

This underclay may then be viewed with every probability, as the soil in which the plants grew; and the adaptation of such a soil to the plants was obviously due to its alkaline constituent. These primeval plants would not exhaust a soil so rapidly as those of the present day; for they invariably contain a much smaller quantity of inorganic ingredients; and their roots being but imperfectly developed would not furnish much excrementitious matter to the soil. Once admit that an excess of carbonic acid was in the air during this period, and an immense vegetation would be the result. The carbonic acid being once extracted could only be returned to the atmosphere by a complete decay of the plants which had used it as food. But we find that the plants constituting coal have been subjected only to partial decay. They have yielded up most of their oxygen, but their carbon has been for the most part retained; their hydrogen has also in a great measure disappeared. From the composition of coal compared with that of woody fibre, it is obvious that during the formation of 800 cubic feet of Newcastle splint coal, the atmosphere must have received 800 cubic feet of oxygen gas, and lost a corresponding quantity of carbonic acid. Now, suppose we were to calculate the quantity of carbon in all the carboniferous deposits at two thousand billion pounds (a quantity which must be much under the truth); then during its formation no less than 64,000,000,000,000,000 cubic feet of carbonic acid must have been extracted from the atmosphere, and a like quantity of oxygen gas returned to it.* This is equal to $\frac{2}{3}$ds. of the quantity of carbonic acid

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* 1000 lbs of charcoal in burning produce have 32,000 cubic feet of carbonic acid. 1000=32,000, or 1=32 : 2,000,000,000,000,000 lbs. will produce 64,000,000,000,000,000 cubic feet.

$$\frac{2,000,000,000,000,000 \text{ lbs.}}{2240 \text{ lbs.}} = 892,857,142,857 \text{ tons.}$$

But the assumed number, 2,000,000,000,000,000, is impirical, and we have, therefore, to shew it is not *above* the truth, however far it may be below it. Now we have already seen that Manchester by fuel, for *domestic purposes alone,* sends into the air, every year, 23,614,285,714 cubic feet of carbonic acid. And, taking its manufactories into the calculation, we may safely suppose, that the total amount will not be less than 46,000,000,000. Now—

$$\frac{64,000,000,000,000,000}{46,000,000,000} = 1,391,304$$

present in the whole extent of the atmosphere. And when we consider that this is but a portion of the carbonic acid removed, we may reasonably conclude that the atmosphere contained, at the commencement of the great carboniferous epoch, more than double the quantity of carbonic acid which it does now.

We have no grounds for affirming that there is a less vegetation now than in early times. On the contrary, it is highly probable that the vegetation now is much greater than that of former periods; but it is no less certain that the vegetation of former times was *vastly more luxuriant at given places.* For the continents being of smaller dimensions, more carbonic acid could be spared to support a luxuriant vegetation in a confined area. It is owing to this great luxuriance of vegetation, within a limited district, that vegetable remains were accumulated in such quantity as to defy even a remote analogy at the present day.

Without reference to geological epochs, I may here state in what manner coal and lignites are produced. The two principal kinds of coal are, the wood, or brown coal of Germany, and the stone, or mineral coal so abundantly found in our own country.

The wood coal, from its composition, has evidently been formed by a regular decay of plants with limited access of air. Hence the hydrogen is still present, whilst the oxygen has disappeared along with carbonic acid. Mineral coal, on the other hand, is distinguished from wood coal by containing a very small portion of hydrogen. Wood coal has been formed by the evolution of carbonic acid from the substance of the plants composing it; whilst mineral coal has been formed from the expulsion of part of its elements in the form of combustible oils. These oils may often be procured from the coal by distillation. Heat appears to have been the cause of the expulsion of these oils. A remarkable example occurs in a quarry within a few miles of St. Andrews, between that town and Cupar. A basaltic rock which has penetrated through the carboniferous strata, forms a hill in the locality alluded to; this rock is thoroughly impregnated with coal naphtha. At whatever part a fragment may be broken off, the fresh surfaces are quite humid with an imprisoned

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That is, Manchester would consume the total amount we have supposed to exist in 1,391,304 years. Or supposing that there were in the world about 65,000 places consuming the same amount of fuel as Manchester, the total amount of coal in the great carboniferous deposits would be consumed in about twenty-one years. But this is obviously absurd, for we know that there is a much greater supply than this. Hence our original empirical number, instead of being above, must be much under the truth.

fluid, which almost instantaneously evaporates; this fluid has the smell and all the properties of coal naphtha. The great difference, therefore, in the formation of wood and mineral coal is, that in the production of the former, carbonic acid is evolved; in that of the latter a hydrocarbon. Hence it is that no combustible gases exist in the mines of wood coals, whilst they abound in those of mineral.

But be this as it may, our conclusion is still the same: that during the formation of the carboniferous deposits, much carbonic acid was abstracted from, and much oxygen furnished to the atmosphere. From the very low numbers which we assumed as indicating the weight of coal in the carboniferous strata, we have seen that its conversion into carbonic acid would nearly double the quantity of that gas now in the atmosphere. But the marine plants, which probably abounded in the same proportion as the terrestrial, have left few evidences of their former existence. They are so perishable in their nature, and surrounded by an element which aids their decay, that their preservation was highly improbable. But during their decay, the carbonic acid from which they were formed, must have been given to the surrounding water; and probably entering into chemical combination with some of its materials, was not again restored to the atmosphere. From whence came all the carbonic acid in the limestones not formed by the accumulation of shells? some of it, certainly, may have been derived from the source just mentioned. Nor are we to allow ourselves to be misled by the belief that the quantity of carbonic acid evolved from such a source, would be too small to exercise an appreciable effect. The decomposing organic matter has perceptibly affected the whole mass of the ocean in its vast extent; for all the recent analyses of sea water prove the presence of sulphuretted hydrogen—a gas only generated by the action of decomposing organic matter on salts of sulphuric acid. There are salts of lime in sea water, particularly the sulphate of lime, now this salt is very easily decomposed by a carbonate. Supposing that during the decay of the marine plants, which every analogy leads us to suppose must have existed in quantity proportional to the terrestrial, an alkaline carbonate was produced; this acting upon the sulphate of lime would occasion a precipitation of carbonate of lime, and give rise to those soluble alkaline sulphates, which we find in such quantity in sea water. By this suggested explanation, I by no means infer that this was a general mode by which the stratified limestone was produced: the undivided limestone could not possibly have been produced this way. But it is possible the thin layers of limestone which occasionally alternate with the shale, sandstone, or coal, in the coal formation, may be due to such a cause. Or might we not conceive that the bituminous limestone shale might also owe its production to this? The immense mass of undivided mountain limestone could by no possibility have been thus produced, but may have well been, by the deposition from solution through the instrumentality of the causes I have formerly described. Once allow, with many geologists, that the ocean was in a heated state during a great part of the primary period, and we are furnished with another mighty means of abstracting the carbonic acid from the atmosphere. The heated waters of the ocean could not dissolve carbonic acid, but as they cooled this gas would be absorbed from the superincumbent air; and the water which evaporated and again descended as rain, would bring down in solution large quantities both of carbonic acid and ammonia.

Taking such things as these into consideration, together with their possibility or probability, it is obvious that we have lost all data for calculating the amount of carbonic acid in the air, at the commencement of the secondary period. Allowing them even a shade of probability, we could not deny that the former atmosphere may have contained more than twenty times the amount of carbonic acid that it does at present; and admitting that it did so, we can account for the extraordinary luxuriance of the primeval vegetation, and for the absence of land animals whilst that vegetation lasted.

During the period at which the carboniferous strata were deposited, neither reptiles, birds, nor mammalia appear to have existed: nor was it possible that they could have existed, were these views of the state of the atmosphere correct.

It is not my intention to detain you, nor is it my province to wander with you step by step over the various geological epochs. In our brief sojourn in the carboniferous strata, we have seen that several, possibly many causes, were in operation to remove carbonic acid from the air, and consequently to fit it for the support of animal life. But let us not suppose that these causes ceased with the termination of the carboniferous era. They still operated though in a less striking degree during all the divisions of the secondary period; but during the deposition of the new red sandstone, they appear to have been in a great measure dormant. It is the duty of the geologist to explain what physical causes then existed which were so unfavourable to animal and vegetable life. But the causes which acted during the carboniferous period were again revived with the oolitic system; and, accordingly from the coal occurring in it, we draw evidences of a removal of carbonic acid from the atmosphere, and a supply of oxygen to it. But here also we are struck with the new forms of animal life which have now sprung into existence: the saurians which began to appear in the new red sandstone, have now multiplied, and play on the shores of the oolitic land. Insects inhabit the luxuriant forests which cover the land; and that most extraordinary of all created beings, the pterodactylus, or flying lizard, executes the functions for which it was designed. The sea has acquired new inhabitants; not only monstrous reptiles, but new forms of fishes, zoophyta, mollusca, and articulosa. But still we find neither birds nor mammalia. The plants of this series afford evidence sufficient of a tropical climate; but the saurian animals furnish proof yet more conclusive. You may remember the cause of animal heat, as I stated it to you in a former lecture. It is a combustion of certain unazotised ingredients of food by means of the oxygen of the air; and as a product of the combustion, carbonic acid and water are formed. The heat occasioned by the conversion of the carbon and hydrogen into carbonic acid and water in the interior of the body, must be as great as if the elements were burned in the open air.

We mentioned that it was quite possible that marine animals may have existed when terrestrial animals could not. Of course the grand object of respiration is the same in both classes of animals, viz. transformation of the food, and of particular constituents of the blood, by means of the oxygen of the air. Hence aquatic respiration differs from the aerial only in that water becomes the medium of conveying the air to the respiratory organs. In the lower classes of marine animals, the respiration is entirely cutaneous, the air not being supplied through distinct channels, but by a transudation through membranes permeable to it. As we go higher in the scale we find a bronchial respiration, or respiration by means of lungs. In these the water holding oxygen in solution meets with a net work of veins, and aerates the blood circulating within them. The cause of animal heat being a combustion of carbon and hydrogen by means of oxygen, it is obvious that in the cold-blooded animals, the quantity of oxygen required will be much less than in the warm-blooded. Accordingly we find this to be the case. A tench lives for some time in water containing only $\frac{1}{5000}$ its bulk of oxygen; whilst river water generally contains from $\frac{1}{2}$ to 1 per cent. of this gas. Unfortunately

I am not aware of any experiments which shew, how much carbonic acid may be in water without being detrimental to the life of marine animals; but certain it is, that the luxuriant vegetations which analogy leads us to believe must have existed in the sea at this period, would extract carbonic acid from, and furnish oxygen to the surrounding water.

The amphibians require very little oxygen for the support of their vital functions. Frogs will live for four or six hours in an atmosphere of pure hydrogen or nitrogen, which does not contain a particle of oxygen. And although the amphibians require less oxygen than the terrestrial saurians, still we find that the economy of the latter requires much less oxygen than that of higher animals. Their lungs are therefore, comparatively imperfect, and the two systems of circulation incomplete; for their arteries circulate a mixture of venous and arterial blood. I do not know if there are any experiments on record, of the powers of any particular saurian to live in an atmosphere deficient in oxygen and surcharged with carbonic acid, such as we suppose existed during " the age of reptiles." I hoped to have been able to shew you some experiments of their power to do so; but from their general torpidity at present, I have not been able to meet with any lizards to secure for this purpose. In a few weeks, however, they will be coming out of their holes, and I shall introduce them into an atmosphere of the olden times, such as their progenitors revelled in when they were masters of the world, and multiplied themselves to such an amazing extent.

All reptiles are distinguished by the small amount of food which they consume, and by their tenacity of life under very trying circumstances. The food which they do take is not of a nature to be transformed into carbonic acid; nor are their organs of respiration suited for this transformation, even if it were. Hence it is, that they do not require much oxygen for the support of their respiratory functions, and that they expire so little carbonic acid. Hence it is also, that they depend upon the warmth of the air to keep up the temperature of their bodies, having no means of generating heat within. Considering then these facts, and the supposed nature of the atmosphere during this period, we discover a sufficient cause why this should have been (as Mr. Mantell aptly denominates it) " an age of reptiles ;"—they did not require much oxygen, which the air could not have afforded. Their respiratory functions were not retarded by an excess of carbonic acid, which would have proved fatal to animals of a higher organization; nor did they come in collision with the plans of the intelligent Creator to remove from the atmosphere by means of organic life the excess of carbonic acid.

From these facts we see that reptiles could have had no difficulty in living in an atmosphere containing less oxygen than at present; but we find that in the oolitic period, a particular kind of quadruped existed. This seems to have been a marsupial animal allied to the didelphys. It was evidently an insectivorous animal, from the conformation of its jaw bones found in the Stonesfields oolitic beds, where the elytra of land beetles are found accompanying them. Now can we find nothing in the respiratory system of the marsupials which would lead us to believe that they might have been in an atmosphere such as we have supposed to exist? The marsupials of course breathe, like other mammals, like man himself, by the lungs alone; and if any peculiarity of the respiratory system existed in the primeval didelphys, we could scarcely expect to find anything but mere traces of it in its modern congeners, changed as they must have been to suit the varied conditions of the atmosphere; but let us try to discover whether such traces may not have been preserved.

Now in saurians, chelonians, and fishes, two canals are observed to issue one on each side of the anus into the peritoneum, that is to the external surfaces of the viscera. Their use seems to be to carry on a partial aquatic respiration, or, in other words, to supply aerated water to the blood circulating in particular vessels. It would also appear that more highly oxygenated blood is required for those vessels which supply the brain. This adjunctive respiratory system is supposed to subserve this purpose. Its presence evidently indicates a want of oxygenation of the blood. *Now it is very remarkable that traces of these canals exist in the marsupials.* Mere traces, however, of any structure, do not subserve functions: they may be considered in two lights, either as remains of what have been, or as general indications of some of the phases through which all the parts of organized bodies pass during developement. Before drawing conclusions regarding the full development of these traces in former types, we must also remember, that no class, order, family, or genus of animals or plants, ever did or ever can pass, beyond the bounds of the type after which they are formed. Again, traces do not *necessarily* indicate that a *full development once* existed in the family; it only proves, that such a family was or is made after the type of some division or other of the animal or vegetable kingdom; hence the traces may never have been fully developed at all,—they may be consequences of a *law of development*, and not active organs, or parts in the organism in which they are found. Thus in the present state of physiology, it would be rash to draw the conclusion that the traces of the canals to which we referred as now existing in marsupials, are certainly but the remains of what were fully developed in their primeval types. We incline to the idea, and suggest it to the consideration of those more conversant with such subjects; but at the same time allow, that it is not a *necessary* consequence of their existence, although it may be a *probable* one. So far, however, is certain, that it forms a kind of connecting link between the respiratory systems of marsupials and reptiles. But, in considering a matter such as this, we must not confine our views to the respiratory system alone, but must take into consideration the whole organization of the animal, and the peculiar connection of its various systems, with their modes of reaction. Viewing it in this light we find the animals in question occupying only a low position in the scale of creation; it is, therefore, highly probable that they could live in an atmosphere considerably worse than they now enjoy. Here, again, I must apologise for want of a few experiments which would have at once decided the question; but the short time which has elapsed since I was requested to prepare this lecture for you, has prevented me from procuring an opossum to treat to such an atmosphere. Any of you who may have such an animal may easily satisfy yourselves by a few experiments.

But whilst wandering through these ancient lands, how comes it that we have not met any of the winged tribes? Forests are there to form a habitation—insects abound to afford them food; the genial climate or the smiling face of nature invites them to sing its praises. But in vain we penetrate the deep recesses of those ancient forests to discover traces of the feathered songsters of former days. We search the shores and the rivers to find aquatic birds feasting on the fishes which so abound, but we are scared away by the saurians which line their banks. We enter the forests, and meet nought but the monstrous pterodactylus sailing along on its filmy wings. If birds existed, where are their remains? Though rare, still we find them scattered throughout the tertiary and modern lacustrine deposits. Why is there not a single evidence of their existence in all the secondary strata? Simply because (if our view of the state of the atmosphere be correct) they could not have existed. Birds require a very large supply of oxygen for the support of their vital functions, and are peculiarly susceptible to the effects of an excess of carbonic acid. Neither of these conditions being yet favourable, nature was not fitted to receive them.

But we have now nearly approached the termination of the secondary period, for the paucity of terrestrial plants and animals in the cretaceous series and greensand does not tempt us to linger long amidst their oceanic deposits. But to the chemist it seems strange from whence came those vast deposits of carbonate of lime in the cretaceous beds. The plants are not numerous, and almost entirely marine; yet from the quantity of pyrites which occurs, it is apparent vast quantities of organic matter must have been in decay.

The perishable nature of marine plants prevents them being accumulated in very large quantity. Hence we might still conceive, that the ocean was covered with marine plants at this period, which by their decay might so furnish carbonic acid as to decompose the sulphate of lime existing in the sea water, and thus occasion the deposition of carbonate of lime; thus the atmosphere would be robbed of large quantities of carbonic acid. But the magnitude of such deposits astonish us, and would compel us to relinquish this, even as a partial cause, did we not, on the other hand, consider the great extent of geological epochs.

Now comes the close of the secondary period. We have glanced at the nature of its organic remains, from the silurian rocks to the greensand; we have been struck with the development of organic life; we found it partly owing to the physical conditions and positions of land and sea—and with these we had nothing to do;—but we found it also dependent on the chemical constitution of the atmosphere; and that when vegetation gradually purified the air from its noxious ingredients, other forms of animal life sprung into existence. When traversing these lands of former times, it is difficult for us to conceive that we are examining our own world. The striking progression of organic life must have been due to some cause. Why, may I ask the followers of Lyell, who believe that organic beings may have existed long before the primary periods, although their remains have been destroyed by heat—why this progression of animal life? And, wherefore, may I ask the followers of Daubeny, did land animals not sport in the forests of the carboniferous land? No mighty operations of nature then acted as antagonists to their existence; the climate must have been congenial; the war of the elements not greater, if so great as now. And wherefore, when in the course of ages, those forests become entombed, did land animals then start into being? Can these, or many similar questions be replied to, without admitting some changes in the states of the medium in which both plants and animals exist, or can the uniform progression of animal life be attributed to entirely local or adventitious causes? Let us not contort the face of nature to give countenance to our theories, but let us frame those theories on nature as it is.

Following, therefore, the train of reasoning which we have adopted, we are struck with amazement in stepping over the boundary which separates the secondary from the tertiary periods. We no longer encounter those monstrous reptiles which haunted the shores and rivers of former lands; we do not now wonder at the vast difference of the former state of things, but feel a difficulty in believing we are not looking upon a world similar to our own. We have seen that the forms of animal life either gradually run into one another in the various strata, or that these were separated by a distinct line of demarcation, and characterised their own peculiar class of fossils. With respect to land animals, we have also seen that when any great addition of forms was effected, evidences exist of causes having been in operation to remove carbonic acid from the atmosphere. Now, whence do we derive the evidences of this withdrawal in the era between the secondary and the tertiary periods? Nothing can be more striking than the difference of organic remains between the infra and supracretaceous beds. The supracretaceous deposits are characterised by the wonderful similitude of organic remains to types now existing—the infracretaceous, by their utter dissimilarity. On this account we are disposed to lay more weight to our former explanation of the manner in which the cretaceous beds may have been formed; viz., by a decomposition of the sulphate of lime existing in sea water by means of carbonates formed through the agency of decaying plants. Such, at all events, may have been a partial cause, and would account, in a great measure, for the small coherence and chalky nature of the limestone; a character of a precipitate.

There are many circumstances which countenance this idea. The recent experiments of Kuhlman on the preparation of artificial stones by means of silicate of potash, are powerful advocates of its truth. There cannot be the slightest doubt that silicate of potash formed an important ingredient in the sea of former times; every rock of marine origin proves this. Now, as the carbonic acid was evolved by the decay of the marine vegetation, it would decompose the silicate of potash, forming carbonate of potash, and depositing silica. This carbonate of potash again meeting with the sulphate of lime in solution, would occasion the double decomposition of which we have spoken. And that these chemical changes did take place, the composition of the chalk shews us; for it every where contains both potash and silica. The organic remains converted into silica owe their origin to a like cause; that is, to a gradual deposition of silica, from the silicate of potash decomposed by means of the carbonic acid evolved during their decay. The infiltration and decomposition of this salt would then give the coherence to the chalky beds which they now possess. Indeed, to the infiltration of silicate of potash may be ascribed the conversion into stone of all the argillaceous and calcareous deposits; assisted, of course, by heat.

I am well aware that the supposition which we have advanced has to encounter a very serious objection in the paucity of vegetable remains found in these beds; but this objection is by no means conclusive against the opinion. The plants found in them are all marine, and from their perishable nature could not be accumulated in quantity. Besides, the loose nature of the deposit would long admit of the access of water, which would ensure their decomposition. This circumstance must be allowed its due importance; for the impermeability to water in chalky beds is vastly inferior to that of arenaceous and argillaceous deposits; and the experiments of Dr. Lindley have proved that long immersion in water destroys most plants. Allow, then, even this suggestion as a partial cause (but we see no obstacle in assuming it as the universal one), and there is no difficulty in accounting for the withdrawal of carbonic acid from the atmosphere during the deposition of the cretaceous beds. In consequence of this withdrawal, the atmosphere becomes fitted to sustain higher forms of organic life, and these accordingly sprung into being during the tertiary period. During the tertiary period itself, this withdrawal of carbonic acid from, and supply of oxygen to, the atmosphere, was constantly proceeding, as the vast beds of lignite on the Rhine amply testify; and a gradual increase of forms of animal life is accordingly observed, from the basis of the tertiary rocks, to the summit of the series. It would be desirable that more conclusive evidences were furnished of the age of the brown coal: in absence of information to determine to what part of the series it should be placed, we must keep from drawing conclusions regarding it; the general inference, however, may be drawn, that these entombed lignites do certainly not belong to the newer part of the series.

Although we find very many species in the tertiary strata similar or identical with those now inhabiting the earth, still neither in these nor in the post tertiary or alluvial deposits, do we find any trace of man or of his works. But previous to his creation it became indispensable that a balance should be established between animal and vegetable life. It was the commencement of a grand era that ushered into the world an intellectual being. Nor can we conceive that a creature so noble, stamped by the image of its Creator, could be destined, like those animals which had become extinct, to be swept in its turn from the earth by causes similar to those which had effected their extinction. The creation of an intellectual being was not an occurrence coming in the common order of events; but man must have been placed upon the earth by a fiat of the All-powerful Creator. The present order of the globe was ordained for him, and all things proceeded to fit it for his habitation. We will not deny that he who made man might likewise ordain that he should be swept from the earth; but we do deny that the exhibitions of the causes destined to produce this would be in uniformity with the usual designs of Providence. It would be ill-accordant with a divine wisdom to suppose that it had not arrested the causes which led to the extinction of whole tribes of animals, when it called man into being. But it would as little harmonize with our conceptions of the Creator's works to imagine that any divine interposition or miracle altered the face of nature, immediately antecedent to the creation of that intellectual being. Laws were instituted, by which this earth is governed, and we must look for such changes in the natural current of their operation, not in their annihilation or alteration. Now if I have carried you along with me in the description of events which have proceeded on the earth from the first dawn of organic life, you will find no difficulty in discovering, or admitting with me, that the grand causes for the extinction of animal life were now removed. We have seen all the primeval lands, which we have hastily traversed, covered with a luxuriant vegetation, but containing a disproportionably small number of forms of animal life. We have approached more nearly to our own epoch, and remarked the gradual increase of these forms; and at the same time, we have seen that the atmosphere which covered those lands, gradually changed its character. We have remarked that the first forms of land animals were such as could live in an atmosphere destitute of its present proportion of oxygen, and such also as did not return any notable quantity of carbonic acid to the atmosphere. But we remarked also a great change as we approached our era:—the animals existing in strata antecedent to modern deposits were all furnished with respiratory organs like our own; that is, with organs fitted for abstracting oxygen from the air, and returning carbonic acid: functions quite opposed to those of vegetables, which abstract carbonic acid and return oxygen. Hence, as soon as animals become sufficiently multiplied to supply the amount of carbonic acid to the air, equivalent to the quantity abstracted by growing plants, a balance would be struck, and the air could not experience any appreciable variation. For even supposing that by some adventitious circumstances, such as by volcanic agencies, an increased supply of carbonic acid was furnished to the atmosphere, the effect would simply be to induce an increased vegetation, and the excess would be withdrawn. On the other hand, if the amount of carbonic acid became diminished, vegetation would be retarded, and it would attain its normal standard. Such would be the natural effects of vegetation, when the original amount of carbonic acid in the air had become reduced to the point at which it ceased being detrimental to animals, but was still sufficient to administer to an ordinary, but not excessive luxuriance of vegetation.

But here a curious question arises—Does the progress of human society not occasion a greater demand for carbonic acid, and thus serve to destroy the equilibrium between plants and animals? It can scarcely be denied that civilization causes an increase in the aggregate of animal life. The preponderance is great between the animals depending upon man, and those destroyed by him. Nay, even the increase of human beings produced by an augmentation of the comforts of civilized life, would demand our serious attention to the enquiry. Once admit, and I do admit it for the sake of argument and probability, that civilization increases the aggregate of animal life, and it is evident we must find some means of compensating to the air for the carbon and nitrogen abstracted and retained by this increase. For were there no means of compensation, other parts of the earth, existing in a state of nature, would suffer for the supply of those parts subject to the dominion of man. The difficulty of finding an answer to this question has furnished a specious argument to those who refuse to admit that the food of plants is derived from animals; and yet the explanation is not so difficult. Which would require the most carbonic acid—America with its forests and extensive prairies, or America peopled by men, and covered by fields of waving corn? Civilised man enters America, he expels its tenants from their native soil, cuts down their forests, and plants in their stead agricultural produce. Strange as it may appear, he has caused neither an increase nor a diminution in the amount required; for it has been proved by Liebeg that the same extent of land produces the same quantity of carbon, whether it be covered with forests or agricultural produce. He increases himself to an amazing extent, and thickly peoples that once thinly populated country. True, by his increase, he removes from the air quantities of carbonic acid, but he compensates for this by the habits of civilization. He has cultivated in the place of forests plants requiring a large supply of nitrogen. This nitrogen he is peculiarly fitted to supply them with, from the effete matter discharged by him. The air contains much more ammonia than is necessary for the purposes of wild plants; he abstracts out of its superabundance, and merely concentrates it at particular spots, where it meets with plants which peculiarly require it, but none of it is lost to vegetation. The peculiar habits of civilized life cause him to return to the air carbonic acid, amply compensating for that abstracted by his increase. In the form of coal he digs from the earth, and returns to the air the carbonic acid of former times. The great stream of air which, by the revolution of the earth moves from the equator to the poles, wafts in its return this food to tropical climates, where nature yet revels in all her wildness. The food thus sent is immediately appropriated by a luxuriant vegetation, and oxygen of course emitted, which the same stream of air, in its progress towards us brings back to supply that consumed in the formation of the food. Thus man, by the habits of civilisation fully compensates for that which he retains by his own increase, and that of the animals dependant upon him. Upon the compensation of ammonia, I have almost said enough. The plants of former ages were not such as to require much nitrogen; hence, although the decrease of carbonic acid from the air was great, that of ammonia was insignificant. The greatest exhausting cause in operation would be the rain which carried it to the sea, and caused it to remain there; that falling on the land would again evaporate. And though the increase of animal life may, as we have already said, remove for a time the superabundance, this will finally benefit vegetation. But all this time I have been silent regarding volcanic agencies. I have been so, because I consider them merely as an auxiliary means of furnishing to the air the carbonic acid and oxygen retained by animals during life; but by no means as being the primary sources of food.

I would I could dwell longer upon these subjects: they are of too extensive a nature to be embraced in a single lecture; but for you I have been already far too long. My end will be gained if some of you have been convinced that the grand causes formerly in operation for the destruction of animal life have ceased, and that man is not liable to the destructive agencies of former times—if you are convinced that by wonderfully wise plans of Providence, the grand medium of animal and vegetable life, the atmosphere, has become fitted for the reception of man, and attained a state of repose and perfect equilibrium, by the exquisite adjustment that *Death* has become the source of *Life.*—And if my illustrious namesake, when supporting the theories of Hutton, in his assertion that the world shewed no traces of a beginning, nor none of an end—meant to include that the organic life on it is also destitute of such traces, we cannot assent with him. But that no evidence of a beginning, nor of an end exist in the world itself, we fully admit; yet that that beginning was, and that an end will be, we have the word of One "that cannot lie."—*Annals of Electricity.*

A General View of the Environs of Pekin. By M. KOVANKO, *Major in the Corps of Engineers of Mines; translated by Lieutenant-General Lord* GREENOCK, F. R. S. E., *from the Annuarie du Journal des Mines de Russie, année* 1838. *Published at St. Petersburg,* 1840.

Pekin is situated in a plain bounded on the north-west by a series of mountains belonging to branches of the chain *Tkahï-Khanc*, which takes its origin at the Yellow River, and is prolonged to the north-east nearly as far as the sea of the same name.

The Chinese distinguish these mountains as Northern and Western, according to their position relatively to the capital; they are, besides, equally to be distinguished by the nature of their rocks.

Limestone, together with dolomite, predominate in the Northern Mountains, and in those of the West, diorite (greenstone), with all its varieties, as well as sandstone and slates containing beds of coal. These two series of mountains being cut in different directions by defiles and steep valleys, it is difficult to determine their point of connection.

The Northern Mountains are a day's journey from Pekin, which does not imply any considerable distance: the Chinese travel so slowly that they never go farther in one day than from 60 to 80 li,* or 34 or 44 versts. The road in the direction of these mountains passes over alluvial clays containing much lime. In very dry weather, this clay becomes so hard that it can scarcely be broken with a pickaxe, while in wet weather it becomes entirely liquid, and forms mud that is nearly impassable. In summer this road is very picturesque; vast fields extend beyond the view on both sides. Notwithstanding the labour and expense which are required at that season for the cultivation of this land, the farmer is amply repaid by the abundance of the harvest, which supplies at the same time bread for himself, food for his cattle,

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* The li is equal to 274½ sagénes of Russia.

and even fuel, for the grain of the yellow millet *(Syao-mi-tsra)* furnishes meal, the only food of the peasants, and chopped straw for the cattle in place of hay, which is never cut, and of the use of which even they have no idea in China.

It is with the straw of a kind of millet called *Gao-lianes,* which grows to the height of fifteen feet, that the peasants make fences for their gardens; they employ it also for fuel in their houses, and to burn bricks. The grain is used instead of oats to feed the mules, and brandy is obtained from it by distillation.

About 15 li (8 versts) before arriving at the Northern Mountains, is seen the little hill *Syao-Tan-Chan,* composed of compact grey limestone, traversed by veins of quartz, which give it great hardness. This mountain, though of little elevation, deserves particular notice from the existence in its neighbourhood of two hot springs, which burst forth nearly vertically from an unknown depth. These springs, at the distance of a few sagénes from each other, have different temperatúres, one of 40°, the other of 45° Reaumur (122° to 133° F.) The water from these springs flows into basins lined with a masonry of compact limestone, from whence it is conducted by leaden pipes into baths cut in the limestone, and lined with sheets of lead.

A palace, surrounded by a garden, has been erected near the baths, destined for the imperial family. The stone-wall by which it is enclosed is in a complete state of dilapidation, no repairs having been made there for fifteen years, although the buildings of the Chinese are frequently in need of them. The water is perfectly transparent, and contains no salt in solution. Its use consists in procuring the bathers a copious perspiration. The baths are frequented by many persons of the inferior classes in the spring, who either come there for their health, or merely as an object for an excursion.

Three li to the west of *Syao-Tan-Chan,* there is another insulated mountain called *Da-Tan-Chan,* a little more elevated than the former, and formed like it of compact limestone full of quartz veins. The base of this mountain gives rise to many springs, one of which has a temperature of 16° R. (68° F.) and the water is very pure.

There was formerly at this place an establishment for baths of cold water, but it is now in ruins, as are also the temples which were in the neighbourhood of the spring. In general, the priests of the temples of the religion of *Khê-Shan* and of *Da-o,* exercise hospitality. Travellers may always find a lodging with these hermits; it is true that their services must be largely remunerated, but they must of necessity have recourse to them, there being no other places where accommodation can be obtained. In the convents, 10 roubles* is the lowest price for a rest of a few hours, and, for a whole day, 25 roubles are not considered to be sufficient. From this it may be easily judged how costly even the shortest excursions in the environs of Pekin must be.

The outline of the Northern Mountains is pretty uniform ; they are, generally speaking, nearly bare, their flanks being rarely covered by small bushes, and alluvia of little importance.

These mountains are of considerable elevation, particularly that of *Syao-Chan*, situated 30 li to the north-east of the temple *Loun-Tzouan-Sy*, which is distant 60 li north from Pekin. It is principally composed of granite, of which the lower part, being large grained, decomposes into gravel ; the upper portions are small grained, and shew no signs of disintegration. This granite consists of red felspar, clear grey quartz, with a vitreous lustre, and black mica, altogether imperceptible in some places. No other minerals of any consequence have been found in it. To judge from the name it bears *(In-Shan)*, which means the mountain of silver, there is reason to believe that it formerly furnished the ore of that metal; and, indeed, one of the hermits dwelling in the neighbourhood, a man of about seventy years of age, assured me that in his youth a vein was worked in that mountain, the ore from which was taken out at night and secretly smelted to obtain the silver.

The shaft of the mine to which he alluded, is now filled up and covered with buildings; there was therefore no means of ascertaining the truth of this tradition.

At the foot of Mount *In-Shan*, there existed anciently an immense temple of the religion of *Khé-Shan*, inhabited by 400 monks, the traces of which are still to be seen. A path made on the flank of the mountain led quite to the summit, and the steps hewn in the granite exist at the present day. The path is now obstructed by stones, and overgrown with bushes, so as to render it difficult to climb the very steep acclivity of the mountain. Having proceeded by this path about three versts, I was obliged to surmount a precipice nearly vertical, in which small holes were cut of a size barely sufficient to enable the points of the feet to rest in them. But the trouble of overcoming all these obstacles is well repaid, for the view from the summit of the mountain is of itself an object for the sake of which it is worth undertaking this excursion. The plateau on the summit is encompassed by a balus-

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* 10 roubles = 11 francs 50 centimes; 25 roubles = 28 francs 75 centimes.

trade of granite, very handsomely worked. In the middle there is an altar cut out of a single block of the same rock, and close to it, an enormous bell of cast-metal suspended to pillars of granite.

Notwithstanding the number of ages these monuments have existed, they are in a perfect state of preservation, which proves the solidity of their construction.

The heat was insupportable during my ascent of *In-Shan,* and I was dying of thirst; but a fresh breeze, and some mulberries which I gathered on the summit of the mountain, restored my strength. A kind Providence seems to have thrown some seeds of that tree into a fissure of the altar expressly to alleviate the fatigues of the traveller. With the exception of this mulberry tree, there was not a single plant to be seen in that enclosure.

While I was resting myself, the guide astonished me by his foolhardiness. The abyss over which the mountain projects is so deep, that it is hardly possible to look down into it without feeling giddy; but this man, careless of danger, springing upon the top of the balustrade, went twice round the plateau, jumping from pillar to pillar, distant about one and a half archine from each other. It made me shudder to see him expose himself to so much danger, but he preserved the greatest coolness, and I did not observe the slightest trace of emotion on his countenance.

The view from the summit of *In-Shan* is magnificent. It is the most commanding point in the country. Before me, the crests of the mountains, illuminated by the setting sun, stretch out like the waves of the sea; over head, is a clear blue sky, and in the horizon other chains appear, varying as much in their forms as in the beauty of their tints. From this spot the view embraces an immense space—a pure and light air is inhaled with delight. While I am observing, a majestic eagle hovers so near as almost to graze my head; around me is the silence of the desert; alone in the distance, on the flank of the mountain, a shepherd is driving his flock towards the plain; and here and there rich pastures display their verdure.

Water is very generally wanting in the northern mountains, and only small rivulets, formed by the moisture derived from the atmosphere are met with in the valleys; one of them takes its rise at the base of Mount *In-Shan,* disappears for half its course under detrital blocks and alluvia, to appear again as a spring near the temple of *Loun-Tzouan-Sy.* Its water is very pure, and is reckoned the best in the environs of Pekin. It has been dammed up for the purpose of turning a flour-mill with a horizontal wheel. This place is extremely agreeable during the summer heats. However high the temperature of the air may be, the water remains constantly cool.

In the month of July, at the time of the greatest heat, it is much frequented by bathers: but until then the Chinese are afraid to venture into the water, so great is their dread of the sensation of cold.

The Russians who reside in Pekin astonish the natives a good deal by drinking cold water at their meals in winter as well as in summer; while the Chinese warm even their wine, and never drink cold water except in the hot weather of July.

A great number of fruit-trees, proceeding from plantations, grow in the ravines and valleys of the Northern Mountains, especially many Indian fig-trees, as also peach, apricot, pear, plum, and walnut trees. It appears even that the trees which do not bear fruit, such as the fir, the willow, the juniper, and the cypress, owe their existence to artificial cultivation, which is the reason that not a single forest of any considerable extent is to be met with in the whole chain of the Northern Mountains.

The rocks of which these mountains consist, belong, as has been already observed, to a formation of dolomite, which is there largely developed.

It commences at the temple of *Loun-Tzouan-Sy*, and extends to the north-east as far as the base of *In-Shan*. The mountains of *Syo-Tan-Shan* and *Do-Tan-Shan*, are of that formation; several varieties of dolomite are also found in it; near the temple of *Loun-Tzouan-Sy* it is very compact, small-grained, and the presence of particles of quartz gives it much hardness. All the monuments in the burial-places, the masonry of the door-ways and of the steps in the palace, are of this stone. The compact varieties are seldom white, but generally of a grey colour. When the quartz is absent in this rock, its fracture has the appearance of sugar, and, like that substance, is entirely white, and translucent when in thin fragments. It bears much resemblance to the marble of Carrara. We should not be warranted in assigning a very ancient origin to this rock, although it does not contain organic remains. It has little cohesion of its parts, and is easily reduced to powder; it is in this form that it is used to complete the process of cleaning the rice. Its texture has not the appearance of being foliated, but it is always divided by a great number of fissures into irregular masses, which renders the quarrying of it very difficult.*

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* *Note by the Author.*—About 6 francs (French money) are paid for the extraction of 150 pouds of this rock. The carriage of 15 pouds to the capital, distant 60 li, costs about 60 francs.

The limestone, in a half decomposed state, containing a great quantity of white sand, enters into this formation in subordinate beds. In some places this limestone decomposes to such an extent as to form a white powder which covers the whole surface.

Sandstone, small grained, of a dark colour, traverses this formation also in beds, which alternate occasionally with those of the predominating rock. These beds of sandstone have only a thickness of 1 or 2 archines.

The porphyry, which rises in the form of a mamelon, near the temple of *Ba-or-Sy,* three li to the north-west of that of *Loun-Tzouan-Sy,* appears to have had some influence in the formation of this dolomite.

This porphyry, of a deep red colour, gives out a strong smell of clay. It has but little consistence, and its surface is fissured all over.

The ferruginous red sandstone, which is divided into rhomboidal faces by joints, ought likewise to be classed as belonging to the dolomite formation. It does not constitute any considerable masses, and is only found lying on the flanks of the compact dolomitic limestone. The sandstone, in decomposing, forms an excellent soil for cultivation.

One li to the north-west of *Loun-Tzoun-Sy,* a small outcrop of a chloritic slate, having a coarsely foliated structure, is seen bordering upon the dolomite, which disappears almost entirely under alluvial clay. Its dip is very highly inclined, the beds being very irregular and singularly contorted. Some traces of lime are found in it, but no other minerals.

The Western Mountains, as has already been said, are composed of different rocks. Three formations are distinctly observed in them.

1*st,* Diorite; 2*d,* compact grey limestone, which appears to correspond with the mountain or carboniferous limestone of England; and, *lastly,* the coal formation.

A formation is besides observed, the independence of which is not altogether demonstrated. This is a species of conglomerate intimately connected with the diorite, and which will consequently be described at the same time with that igneous rock.

Dioritic Formation.—Diorite (greenstone) appears at the surface at the village of *San-Ourad-Yan,* and extends in ascending the course of the river *Bourbouse* to the village of *Van-Pin-Koon,* a distance of more than 30 li.

The diorite, small-grained, of a light green colour, is divided by fissures, giving it the form of beds inclined about 15° to the east. This rock is not very hard, except in its inferior portions; but as it acquires elevation, it loses its granular texture, becomes friable and slaty, and passes into indurated clay containing nodules of quartz and of greenstone, which frequently exceed the size of a nut. In some places these nodules occur only in veins in the friable dioritic mass, but sometimes they are accumulated to such a degree as to form enormous masses of compact conglomerate.

The thickness of the beds of the latter, which have the same inclination as the diorite, is about 1 sagéne. They alternate with ferruginous clay of a brownish red colour, forming in some places considerable elevations. This clay also contains nodules of quartz and of greenstone, which, by the decrease of their bulk, pass into a fine-grained sandstone without admixture, and are traversed in different directions by veins of white quartz.

Every thing concurs to lead us to admit that this conglomerate, so intimately connected with the diorite, does not, properly speaking, belong to the dioritic formation, produced to all appearance by volcanic agency (prophyry conglomerates). In my opinion it constitutes a sedimentary rock in the fullest acceptation of that term, in the formation of which the diorite might have concurred.

It would appear that the conglomerate is more recent than the diorite, and that it would be better to class it in the coal-formation, considering it as an equivalent to the old red sandstone of England.

The diorite cropping out at the base of the mountain *Lao-Goua-Shan* to the west of *Van-Pin-Koon*, as well as the conglomerate which overlies it, has a dip nearly vertical. This peculiar inclination might be attributed to some more recent revolution which these rocks have undergone, occasioned apparently by the dioritic porphyry which rises from beneath the diorite, but which, however, does not form any considerable masses.

Vertical seams of coal lie in some places between the diorite and the conglomerate, having the latter for the roof and the former for the floor.

Slate-clay, which has the properties of a combustible slate, from the great quantity of bitumen it contains, forms a border to the coal on the side of the roof.

The border on the side of the floor, although equally composed of slate-clay, contains less bitumen, and has not so much lustre as the former. This coal very much resembles anthracite, because it is shining, of compact texture, difficult to ignite, does not flame in burning, or give out any smoke. Its substance is entirely homogeneous, and every thing respecting it leads to the belief that there had been a great development of heat at the period of its formation.

The beds of conglomerate occupy, in some localities, nearly a horizontal position. In this case the coal included between the conglomerate and the diorite, occurs in beds of more importance, as, for example, at *Daor-Yao* to the east of *Van-Pin-Koon*, where the seam of coal is 1½ archine in thickness.

That which is worked at *Daor-Yao* is brittle, and breaks easily into small fragments of the size of a pea. The blacksmiths, and those who work in copper, consider it preferable to any other coal for their use, on account of the intense heat it gives out.

The conglomerate does not form thick masses. In its upper bed it passes into a true sandstone, which the quartz renders very hard. Occasionally the presence of particles of mica give it a slaty texture, and it becomes friable where clay is principally the basis of its cement.

The brook *Tsin-Schoui-Khê* flows 15 li to north of *Van-Pin-Koon*, and, in cutting through a mass of diorite, it has laid bare all the varieties of this rock. Granitic diorite, compact diorite, and porphyritic diorite, alternate with each other, all passing at length into a conglomerate, which appears to differ from that to which the seams of coal are subordinate, and is the dioritic conglomerate properly so called. The beds of this conglomerate, and those of the diorite itself, alternate with beds of ferruginous clay, having a porphyritic appearance. This rock in some places passes into euritic porphyry, which being sometimes separated, and afterwards reunited afresh by the same rock, forms a breccia, in which the imbedded fragments of porphyritic rocks are from 1 verchok up to ¼ of an archine in diameter. This porphyry is of a brick red colour, with white crystals of felspar; its hardness middling, and it forms continuous masses of an irregular appearance.

Carboniferous Limestone.—This limestone shews itself to the west of *Van-Pin-Koon* in considerable masses, which may be regarded as an independent formation. The mountains which are composed of it have their flanks so steep, that the summits are sometimes inaccessible. The texture is foliated in thick laminæ, and in some localities the stratification of the beds is nearly horizontal. It is traversed by veins of perfectly white calcareous spar, which gives to it a variegated grey colour. A great many caverns of different dimensions, and all of them vaulted, are met with in this limestone, some of which contain stalactites, but they are destitute of organic remains.

The limestone is traversed in the defile or *Yan-Li-Gaou* by veins of galena and brown specular iron-ore, of a quarter of an archine or more in thickness.

Small-grained greyish-yellow sandstone appears in subordinate beds in this limestone. It is not very hard, contains a considerable quantity of clay, and its beds have a thickness which is rather considerable.

The upper beds of this limestone have a great resemblance to that which forms such enormous masses in the Northern Mountains, and it is probable that they both belong to the same formation.

The limestone of Mount *Tzo-Tkhai,* which is distinguished by the great pagoda situated on its flank, near the village of *Shim-En-Gin,* appears equally to belong to the carboniferous limestone. It is very compact, and the particles of quartz give it so great a degree of hardness as to strike fire with steel. Its texture is foliated, but in thick laminæ. In some places it has the aspect of a compact mass. It abounds also in caverns, one of which, *Thao-Yan-Doun,* is remarkable for its size. It is situated on a very steep slope, which renders it difficult of access. Many persons ascend the mountain on purpose to visit this cavern, but there are very few who have the courage to descend into it. Many absurd traditions exist among the Chinese respecting it. They pretend that there is a subterranean passage leading as far as *Katgane,* and that there are stone-bridges over streams running through it, &c. &c. I made the descent into the cave out of curiosity. It appears like a steep gallery, at first tolerably high, but which becomes progressively lower, so as at last to render it necessary to crawl upon hands and knees. It terminates suddenly in a well ascending vertically. It was impossible to explore its farther direction, for at this point the burning wood which served me as a torch gave so little light, that I could scarcely distinguish the nearest objects. The air in the cave is very moist. There are two lateral galleries, one of which is under water; the other descends very rapidly, and is not any more accessible than the others. The cavern may be about 150 sagénes in length. On the bottoms stalagmites are met with, but no organic remains.

Coal Formation.—Slate-clay is largely developed to the east of *Van-Pin-Koon.* So much coal enters into its composition, that in some places it might serve for fuel. The beds often change their direction and sometimes have a dip nearly vertical: the compact diorite (greenstone) which is intruded into this slate in subordinate beds, appears to have been the cause of the irregularity of those which overlie them. The slate-clay alternates with beds of fine-grained sandstone traversed by veins of white quartz, which render it very hard. Beds of coal lie between the slate and the sandstone.

The slate-clay is, as it were, pounded on the surface, and forms a kind of alluvium which covers its flanks. Thick beds of coal are likewise found in this rock, but their quality is very inferior to that of the coal which lies under the sandstone. The coal which the pounded slate covers varies in its properties. It is often decomposed, and its particles have so little cohesion between them, that they are almost reduced to a state of powder.

Beds of ferruginous sandstone, of little hardness, under which are sometimes found rich beds of coal, lie under the slate-clay. Thus the Western Mountains abound so much with coal, that two or three versts cannot be passed over without meeting with outcrops indicating the presence of a great quantity of this combustible substance, which has never as yet been touched by the hand of man.

The coal used for fuel in Pekin, where wood is very dear, is worked on a great scale; but whether in consequence of the abundance of this mineral, or of the obstinacy of the Chinese in rejecting improvements, the result is that the process of mining is still in its infancy with them, while the preparation of charcoal is carried on there with more success and economy than any where else.

Generally speaking, we may consider that the art of mining is still in its infancy in China. They know nothing of the machines which give facility to the work; they have not even a notion of the pumps which are indispensable for the exhaustion of the water. Vertical shafts are not used by them. The imperfection of the works renders the air very dense in the mines, often to such a degree that it is necessary to make openings above on that account, in which are placed ventilating wheels put in motion by the hand. This wheel, although turning incessantly, introduces very little fresh air into the mine. The galleries of the mines are so low that the workmen can scarcely move in them except by crawling.

When the horizontal beds are to be won, continued timbering is used; but in winning the vertical beds, only the roofs and floors are timbered, particularly the latter, in order that the trains which are employed to transport the coal to the surface should slide easily upon them.

Timbering employed by the Chinese is not above two or three vershoks in thickness. It costs, nevertheless, about two copecks per poud.*

The winning of the horizontal bed is carried on in the following

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* Note by the author.—Wood in China is sold by weight.

manner:—A gallery is opened in the bed of coal itself, 1½ archine in height. After having penetrated into it several vershoks, a cross beam is fixed in the roof, by the two ends being let into the walls of the rock; having advanced another archine, a fresh joist is fixed, which is bound to the first by beams placed lengthwise above them. These beams having a distance between them of a quarter of an archene, are covered with brush-wood made into fascines; when this work is finished, they continue to advance within the thickness of the bed, and following its directions.

The floor of the gallery is in like manner fitted with cross beams placed near together; the gallery is thus pushed on until the want of air renders it necessary to put a stop to the work. Below this gallery a second is opened, to continue the working of the coal.

The only difference in the process of working the vertical and the horizontal beds of coal is, that in the first the galleries are not only timbered above and below, but also on their side walls.

The coal taken out is put into baskets, placed upon sledges, which are raised to the surface by manual labour; one basket may contain about three pouds of coal, and one man can raise to the surface about eight in a day; he generally receives at the rate of 30 copecks per basket. The water which accumulates in the mines is emptied by means of small casks, brought up in the same manner.

If the local circumstances are very favourable, adits for letting out the water are driven; but as they are very expensive, they are very seldom had recourse to; at least if the irruption of the water becomes too considerable, it often happens that the works are altogether abandoned.

The only instruments used by the Chinese in working the coal are the pickaxe, the pick, and the hammer. They cut a groove with the pickaxe, and place in it the pick, which is struck upon with the hammer; it is by this means that fragments of coal, weighing from two to three pouds are detached.

The number of workmen differs much in the Chinese collieries, for few among them make their agreement for a work of any long duration; for the most part they never come until the period when they have finished their labour in the fields. The pickers of coal receive about 1½ rouble for half a-day's work, and the overseers for the day about 3½ roubles, and their nourishment besides.

At the place where it is worked, at *Lao-Gao-Shan*, the coal is sold for 60 copecks per poud: its carriage through the mountains on the backs of mules to *Mem-Toou-Goou*, distant 30 li, where are situated the store-houses of the depôt costs about 20 copecks; from thence the coal is transported to Pekin upon camels. In the city the price of coals is 1½ rouble per poud.

There is besides a kind of coal met with at Pekin, brought from the neighbourhood, which is much cheaper, particularly when it is mixed in the proportion of one-half with coal-gravel (or detritus). This coal sells for only 1 rouble per poud, but it gives out but little heat, and is very quickly consumed. The coal-gravel in question is previously mixed with yellow clay, to give it greater consistence. The process is very simple; eight parts of coal-gravel are mixed with two of clay, pouring into the mixture as much water as is required to render it a thick paste. When the whole of the mass has been well mixed, it is put into moulds, in the same manner as in the manufacture of bricks. The pieces thus prepared and dried are used as coal; they produce little heat, and the fire must be constantly fed with fresh doses. This fuel is only made use of among the indigent classes.

Russian Linear Measures.

The Sagéne, or Russian toise, is divided into 7 feet, or into 3 archines,
The foot, ... into 12 inches,
The inch, ... into 10 lines,
The archine or ell, ... into 16 vershoks,
The vershok, ... into ½, ¼, ⅛,

The verst, or mile, is 500 sagénes in length, and is equal to 1067 French kilométres. A verst is nearly ¾ of an English mile, or exactly 5 furlongs, 67 yards.

Weights.

The Russian poud is divided into 96 zolotniks,
The zolotnik ... ... into 96 doleis or parts.
The poud consist of ... 40 pounds,
The berkovetz ... ... 10 pouds.

Coins.

The silver rouble is worth 4 francs (French),
The copec is the $\frac{1}{100}$ part of the rouble, worth 0.04 centimes,
The paper rouble varies according to the exchange, from 110 to 115 centimes,
The copper copec, the $\frac{1}{100}$ part of a paper rouble, is consequently worth 1 cent $\frac{1}{10}$ or 1 cent $\frac{1}{7}$, according to the course of exchange.
The Chinese li is equal to 274¼ sagénes of Russia.—*Edinburgh New Philosophical Journal.*

Agri-Horticultural Society's Journal and India Review.

In 1839 Mr. Griffith, who was attached to the Army of the Indus for the purpose among other things, of obtaining information relative to the productions of Afganisthan, and of taking advantage of such observations as the nature of the campaign might enable him to make, transmitted to England as was his duty, according to the directions of Lord Auckland, from whom he received his instructions, seeds of various useful plants. Of these a Lucerne seed sent from Candahar, although the same species as that generally cultivated in Europe, was found to yield a so far superior crop, that it almost appeared to be a new race, besides being more valuable as a green crop, from its coming in much earlier than the plant produced from English seed. A Clover also sent home by Mr. Griffith to England from Candahar, was found in England to be a new species, and was accordingly named *Trifolium gigantium,* from its producing a heavy crop, and affording a most valuable fodder for horses, &c. These results were published throughout Great Britain and Ireland eighteen months ago; and at page 619, Vol II. of this Journal, an extract from the *Calcutta Eastern Star* of 5th December last, copied from the *Gardener's Chronicle* as well as a still prior notice in the *Friend of India,* made the Indian public acquainted with these results which were highly creditable to the person directly instrumental in effecting them.

In the second Number of the *Journal of the Agri-Horticultural Society, August* 1842, there is published a Memorandum from Colonel Sykes, enumerating the fluctuations in the exports of various productions of India during the last ten years, in which the Cabool Clover is incidentally referred to in connection with the successful efforts, *not* of Mr. Griffith, *but* of *Dr. Royle !*

We have next a Memorandum *said* to be "of considerable interest from the late Sir Alex. Burnes," on the above Clover and Lucerne, *dated long after both these plants were successfully grown in England from Mr. Griffith's seed.* This is succeeded by another Memorandum from Dr. Royle, headed "Clover and Lucerne seed from Affganisthan, by Professor Royle," in which the name of Mr. Griffith is connected with the Lucerne seed, but not with the Clover, which proved to be a new and very highly important article of cultivation in England; the Editor appends a note to shew, that from an old report by Lieut. Irwin, the existence of both the Clover and Lucerne were known in Affganisthan thirty years ago. No one can doubt this, but it is their introduction into England, to which interest is attached, and this is due to Mr. Griffith. Now we cannot for a moment suppose it to have been the object of the writers of these various notices to mis-represent any circumstance connected with these improvements. From the manner in which they are printed, we should rather infer, that they have been inserted in the Journal of the Agri-Horticultural Society, and copied into the India Review, unconscious of what has appeared on the subject in various daily papers and periodicals during the last two years.*

Notice of Books.

The Birds of Australia. By J. Gould, F.L.S., &c., *Parts* I. *to* VI, *folio. London,* 1840-41.

We are indebted to Messrs. Thacker and Co. for an inspection of this very splendid work on the Birds of New Holland by Mr. Gould, favourably known to the Indian Ornithologist, as the author of the no less beautiful Centuary of Himalayan Birds; in which, as well as in the present work on the Ornithology of New Holland, the figures were drawn by Mrs. Gould, a lady possessed of the very highest degree of taste in this peculiar branch of art. In the work now before us, there is more sobriety and real life in the figures, although perhaps the attitudes and gorgeous colouring of the Centuary of Himalayan Birds may be more striking. The figures in most cases are represented according to their natural size, generally either in the act of alight-

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* The introduction of the Deodar, a magnificent Himalayan tree, into England, which is due chiefly to Dr. Falconer, is also ascribed (in these Memoranda, which form the leading article in the second number of the Journal of the Agri-Horticultural Society) to Dr. Royle, in virtue of some office which the latter holds at the India House. The sooner such an office be abolished, we should think, the better; were it to give the person holding it any claim over the services of officers in India.

ing on, or flying towards some appropriate and characteristic plant or insect of the new world, where animal life as well as vegetation presents so many peculiarities. Each part contains figures and descriptions of eighteen species. The descriptions are drawn up with experience in a scientific, and at the same time a popular, and instructive form, embracing a full account of the characters and peculiarities of each bird, its habits, and its haunts. We should be delighted to find space for a full notice of this interesting work, but as it consists of distinct descriptions of species, it would be difficult within the compass of an ordinary notice to afford more than a very general notion of the interest of Mr. Gould's work. In our next, we shall endeavour to find room for a few extracts; in the meantime, we recommend the work to Public Libraries, and also to persons who can afford to possess expensive works on Natural History.

Meteorological Register kept at the Surveyor General's Office, Calcutta, for the Month of June 1842.

The Observations after Sunset are made at the Hon'ble Company's Dispensary.

June. Days of the Month.	Moon's Changes.	Observed at 9 H. 50 M.					Observed at 4 P. M.					Rain Gauges.		Observations made at 8 P. M.				Observations made at 10 P. M.				Observations made at 12 P. M.			
			Temperature.			Wind.		Temperature.			Wind.				Temperature.				Temperature.				Temperature.		
		Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.
		Inches	°	°	°		Inches	°	°	°		Inches	Inches	Inches	°	°	°	Inches	°	°	°	Inches	°	°	°
1	☾	29,410	87,0	89,0	85,0	E. ..	29,310	85,5	83,2	82,0	Calm. ..	0,47	0,50	29,550	86,5	86,0	84,0	29,500	85,0	85,0	83,5				
2		,346	85,1	84,5	82,0	N. E. ..	,234	84,0	81,0	80,4	N. E. ..		1,02	,700	83,0	83,0	82,0	,700	83,0	83,0	82,0	29,100	81,4	81,0	80,5
3		28,910	80,8	78,0	78,0	N. ..	28,278	81,0	79,8	79,9	S. W. ..			28,900	81,0	81,25	80,5	28,950	81,0	81,25	80,5				
4		29,181	80,4	80,2	80,0	S. (high)	29,162	84,0	83,8	81,0	Sw. (high)	*	5,17	29,450	82,0	81,4	80,0	29,450	82,0	81,4	80,0	,500	82,5	82,0	80,0
5		,390	82,4	82,8	79,1	Sw. (high)	,370	82,5	81,5	79,0	S. W. ..	0,26	0,37	,550	84,5	84,0	83,0	,550	84,5	84,0	83,0	,560	84,5	84,0	83,0
6		,418	84,0	84,0	80,4	S. W. ..	,402	85,5	86,0	83,0	S. W. ..	0,66	0,86	,575	84,0	84,0	83,0	,600	84,0	84,0	83,0				
7		,434	85,0	86,1	83,0	Sw. (high)	,406	89,7	90,0	87,0	S. W. ..			,700	85,0	84,5	83,0	,700	85,0	84,4	83,0	,650	85,0	84,0	83,0
8		,529	80,0	79,0	77,0	S.	,490	84,0	84,0	80,0	S. W. ..	0,38	0,47	,700	85,0	84,0	83,5	,700	85,0	84,0	83,5	,750	84,0	83,5	83,5
9	●	,570	84,6	87,5	84,4	S.	,514	89,0	90,4	86,8	S. W. ..			,700	87,0	87,0	87,5	,750	86,5	86,0	86,0				
10		,615	83,0	83,2	80,0	S. W. ..	,585	86,0	86,4	82,8	W. S. W.			,750	86,0	85,4	84,0	,750	86,0	85,4	84,0				
11		,702	85,0	86,0	82,2	S.	,625	83,0	83,0	80,0	W. S. W.	2,06	2,24	,850	85,0	84,0	83,0	,850	85,0	84,0	83,0	29,850	83,5	83,0	82,5
12		,662	84,8	86,0	82,0	S. W. ..	,605	85,8	86,8	83,0	S. W. ..			,800	84,75	84,5	83,0	,850	84,5	84,0	83,0				
13		,565	85,4	86,3	82,5	S.	,542	87,3	88,5	84,2	S.			,700	86,5	85,75	85,5	,700	86,5	85,75	85,0	,700	86,5	85,75	85,5
14		,558	85,2	86,5	83,7	S. W. ..	,522	89,0	91,0	87,0	S. W. ..	0,67	0,94	,700	88,5	88,0	87,5	,700	88,5	88,0	87,5	,700	87,5	87,0	86,5
15	☽	,593	81,0	78,7	77,0	E.	,525	81,9	82,6	79,5	S. W. ..	0,08	0,12	,700	83,4	82,4	82,0	,700	83,0	82,4	82,0				
16		,550	82,4	84,6	80,0	S.	,442	86,8	88,6	82,7	E.			,750	84,0	83,0	82,0	,750	84,0	83,0	82,0				
17		,486	87,3	88,5	83,0	E.	,421	84,4	82,0	80,7	S. E. ..	0,52	0,62	,700	84,5	84,0	83,0	,700	84,75	84,0	83,0	,700	84,5	84,0	83,0
18		,485	85,0	87,2	83,0	E.	,398	83,4	82,8	81,0	S. E. ..	0,51	0,61	,550	84,25	84,0	83,0	,550	84,0	84,0	84,0	,500	82,5	82,0	81,0
19		,390	82,1	82,0	80,6	E.	,326	82,4	82,4	81,0	E.	1,45	1,61	,500	83,0	83,5	82,0	,500	83,0	83,5	82,0				
20		,466	80,5	80,8	80,0	S. E. ..	,445	80,0	79,9	79,0	S. E. ..	2,21	2,47	,500	82,5	82,0	82,0	,500	82,5	82,0	82,0				
21		,554	79,2	77,9	78,0	S.	,514	81,2	81,5	81,0	S.			,650	82,0	82,0	82,5	,650	82,0	82,5	81,0				
22		,535	79,8	78,0	78,0	S. W. ..	,474	79,4	78,1	78,0	Calm. ..	*	3,50	,650	82,5	81,4	81,0	,650	81,0	81,4	81,0				
23	○	,474	79,8	78,6	78,0	S. W. ..	,394	82,4	83,1	82,2	S. W. ..	0,61	0,83	,650	82,0	81,5	81,0	,550	82,0	81,5	81,0	,550	82,5	81,5	81,0
24		,417	80,5	80,5	79,0	W. S. W.	,390	83,0	83,8	82,0	S. W. ..	0,59	0,66	,650	81,5	80,0	89,0	,550	81,5	80,0	81,0				
25		,477	81,2	82,0	79,0	S. W. ..	,453	84,0	85,0	83,3	S.	0,62	0,69	,650	81,0	80,75	80,0	,600	81,0	80,75	80,0				
26		,562	80,7	81,0	78,7	S. W. ..	,533	80,0	79,9	79,0	S.	1,81	2,11	,650	81,0	80,5	80,0	,650	91,0	80,5	80,0	,650	81,0	80,5	80,0
27		,585	81,0	83,0	80,4	S. W. ..	,530	85,4	87,0	84,0	S. W. ..	0,19	0,28	,675	83,4	83,0	83,0	,575	83,0	83,0	83,0	,575	83,0	83,0	82,5
28		,562	84,5	86,5	83,0	S.	,514	86,4	86,5	84,0	S. W. ..			,650	85,0	84,0	82,5	,650	85,0	85,0	82,5				
29		,594	85,0	86,6	85,0	S. (high)	,558	85,9	86,7	83,0	Sw. (high)			,700	85,0	84,5	82,0	,750	85,0	85,0	84,0	,700	83,5	82,5	82,5
30		,614	83,5	85,0	82,6	S. W. ..	,569	85,7	86,0	84,0	S. W. ..	1,06	1,17	,700	84,5	84,5	84,0	,775	84,0	84,0	84,0				
Mean.		29,489	82,9	83,3	80,8		29,418	84,3	84,4	81,9			26.24												

N. B. From a comparison of the two Barometers, the Mercury in that at the Dispensary stands 1-10th of an inch higher than that in use at the Surveyor General's Office.

Meteorological Register kept at the Surveyor General's Office, *Calcutta, for the Month of July 1842.*

Company's Dispensary.

July. Days of the Month.	Moon's Changes.	Observed at 9 H. 50 M.					Observed at 4 P. M.					Rain. Gauges.		Observations made at 8 P. M.				Observations made at 10 P. M.				Observations made at Midnight.			
			Temperature.			Wind.		Temperature.			Wind.				Temperature.				Temperature.				Temperature.		
		Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.
		Inches	°	°	°		Inches	°	°	°		Inches	Inches	Inches	°	°	°	Inches	°	°	°	Inches			
1	☾	29,589	85,2	86,4	82,6	S. W.	29,510	86,8	88,0	85,4	S.	0,13	0,16	29,650	86,0	85,8	83,5	29,750	85,5	85,8	84,0				
2		,553	82,7	83,4	81,2	S. W.	,502	86,3	88,0	84,0	S.			,650	86,0	85,0	84,5	,,	,,	,,	,,				
3		,581	85,2	88,5	85,5	S.	,538	85,0	85,7	83,5	S. E.			,700	85,25	85,0	85,0	,700	85,25	85,0	85,0				
4		,617	85,6	88,4	84,0	S. W.	,542	89,0	92,0	86,8	S.			,750	87,0	86,8	85,0	,700	86,5	86,0	85,0				
5		,589	85,0	88,1	84,0	S. S. W	,490	89,2	92,0	86,3	S. W.			,650	88,0	87,5	85,0	,650	88,0	87,5	86,5	29,650	87,5	87,0	86,0
6		,502	86,8	88,4	84,8	S. W.	,400	89,0	91,5	87,0	S.	0,20	0,25	,600	88,0	87,7	88,0	,600	88,0	87,0	86,0				
7		,422	86,9	88,2	83,9	S. W.	,354	88,4	90,0	86,4	S.	0,18	0,24	,550	88,5	88,8	87,0	,550	88,5	88,8	87,0				
8	●	,386	86,4	88,6	84,7	S. W.	,325	84,2	82,0	82,0	E.			,550	85,5	85,8	85,0	,550	85,5	85,8	86,0				
9		,394	84,4	86,7	84,0	N. W.	,354	84,9	83,0	81,0	W. S. W.			,600	86,0	85,8	84,0	,550	85,8	85,8	84,0				
10		,474	84,2	85,5	83,3	S.	,429	86,0	87,0	84,0	S.			,600	86,0	85,8	84,0	,600	86,0	85,5	84,0				
11		,522	85,7	86,1	84,5	S. W.	,474	85,5	86,1	84,4	S.			,600	86,0	85,8	85,0	,600	86,0	85,5	84,0	,600	86,0	85,5	85,0
12		,525	86,0	89,0	84,3	S. W.	,469	85,0	83,6	82,0	S.			,650	84,5	84,0	83,5	,650	84,5	84,0	83,5	,600	84,25	84,0	83,0
13		,500	82,0	81,5	81,2	Calm.	,450	83,0	82,7	82,0	S.	1,21	1,37	,650	85,0	84,5	84,4	,650	85,0	84,5	84,0	,650	85,0	84,5	84,0
14		,526	82,0	81,5	80,0	S. W.	,457	82,8	84,0	81,0	S. W	0,05	0,07	,650	83,5	83,8	82,0	,650	83,5	83,8	82,0				
15	☽	,502	82,6	83,8	80,5	W.	,446	84,4	85,8	82,1	W. S. W.			,600	83,25	83,0	82,0	,625	84,5	83,5	83,0				
16		,489	81,5	88,3	82,9	W.	,438	85,9	88,2	84,3	S. W.	0,86	0,94	,550	86,5	86,0	85,0	,650	86,5	86,0	85,0				
17		,450	84,8	90,7	86,0	W	,369	86,4	89,0	86,0	Calm.	0,08	0,10	,500	86,9	85,5	85,0	,500	86,0	85,5	85,0				
18		,449	87,0	89,3	86,6	E.	,354	88,5	91,0	86,0	E.	0,13	0,17	,500	87,0	85,5	85,0	,500	86,5	85,5	86,5				
19		,441	85,6	88,0	85,8	E.	,350	85,0	85,0	83,0	S. E.	0,24	0,28	,550	87,5	86,8	85,0	,550	87,5	86,8	85,0				
20		,409	85,0	88,0	84,6	S. E.	,350	86,0	87,0	84,0	S. E.			,500	85,5	84,5	84,0	,500	85,5	84,5	84,0	,500	85,5	84,5	84,0
21		,422	83,5	84,8	82,8	S. W.	,389	86,0	88,8	84,0	S.	0,43	0,43	,500	85,5	84,7	86,0	,500	85,5	84,75	85,5				
22		,465	84,8	86,1	84,0	Calm.	,393	84,5	87,8	85,0	Calm.	0,12	0,17	,550	86,0	85,5	84,0	,550	86,0	85,5	84,0				
23	○	,434	85,0	88,2	84,7	N. E.	,357	84,1	84,4	82,8	E.	0,53	0,59	,550	86,0	85,0	84,0	,550	86,0	85,0	84,0	,550	86,0	85,0	84,0
24		,338	83,9	84,0	81,6	E.	,297	84,1	84,0	81,5	E.	0,19	0,26	,500	83,5	83,0	83,0	,500	83,5	83,0	83,0				
25		,490	84,0	86,5	83,0	S. E.	,474	86,4	88,5	83,8	S.	0,05	0,08	,500	86,0	85,0	84,5	,500	85,0	85,0	84,5				
26		,565	84,2	86,0	83,5	E.	,525	84,3	84,5	81,0	W. S. W.			,700	85,5	85,8	84,0	,700	85,5	85,8	84,0				
27		,541	83,8	81,0	80,6	W.	,454	86,2	89,5	84,8	W.	0,28	0,36	,625	85,75	85,0	86,0	,625	85,75	85,0	85,0	,625	85,75	85,0	85,5
28		,489	84,5	87,1	84,0	N. W.	,398	88,4	90,7	86,0	N. W.	1,97	2,28	,600	85,5	85,5	84,0	,600	85,8	85,8	84,0				
29		,457	81,4	86,0	84,0	S. W.	,357	84,0	82,0	80,8	N. W.			,600	86,0	85,0	85,0	,600	86,0	85,0	85,0				
30	☾	,461	84,4	86,0	84,0	N. W.	,394	86,0	86,4	81,0	S. W.	1,41	1,53	,575	84,5	84,0	84,0	,575	81,5	84,0	84,5				
31		,442	83,5	83,5	82,2	N. W.	,397	85,2	88,0	86,0	Calm.	0,23	0,33	,650	84,0	83,5	83,5	,650	84,0	83,5	83,5				
Mean.		29,485	84,6	86,5	83,5		29,421	85,8	87,0	83,9		8,31	9,61												

N. B. From a comparison of the two Barometers, the Mercury in that at the Dispensary stands 1-10th of an inch higher than that in use at the Surveyor General's Office.

THE

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OF

NATURAL HISTORY.

Description of Camptoceras, a new genus of the Lymnæadæ, allied to Ancylus, and of Tricula, a new type of form allied to Melania.

By W. H. Benson, Esq., *Bengal Civil Service.*

Family.—HELICIDÆ, Swainson.
Sub-fam.—LYMNACINÆ, Sw.
Genus.—CAMPTOCERAS, Nobis.

Testâ elongatâ sinistrorsâ, anfractibus paucis productis, haud connexis, spirâ saliente-subrectâ; aperturâ oblongâ, liberâ, integrâ; peristomate acuto, continuo.

Animal. Tentaculis duobus filiformibus obtusis munitum; oculis magnis inter tentacula sitis; proboscide mediocri; Pallio labia testæ haud transeunte. Pede brevi longitudinem aperturæ vix superante.

C. Terebra. Testâ diaphanâ elongatâ, anfractibus tribus compressis biangulatis, transversè striolatis, lineis longitudinalibus depressis decussatis.

Animali fuscato, versus spiram rubescente.

This is a most interesting type, intermediate between Lymnæa, and the other spiral shells of the family, and the short untwisted conical forms which constitute the genus Ancylus. It is, in fact, an anomalous Ancylus, to the animal of which it approaches more nearly than to that of Lymnæa. It has still less affinity to that of Physa, which has a considerably developed mantle. The motions of the animal are, as in Ancylus, slow, and it adheres rather firmly to smooth surfaces. Camptoceras affords a beautiful confirmation of the correctness of the views of those Naturalists, who, deciding that the resemblance of Ancylus to Patella was analogical, and not one of affinity, and placing it among the Lymnæadæ, with reference to the characters of the animal, separated it from the other Patelli form shells with which it was formerly associated. The analogies of Camptoceras have reference to Scalaria among the Turbinidæ, and to Vermetus among the Tubulibranchia. Occasionally a continuous varix, formed by the lip of a former aperture, adds to the resemblance to Scalaria; but this varix does not adhere, nor extend, as in that genus, to the preceding whorl.

The animal adheres, under water, to the decaying stems of a long reedy grass in a single piece of deep water, evidently forming part of an ancient channel of the river, in the wide alluvial bed of the Ramgunga, north of the station and race-course of Moradabad, in Rohilkhund. It was discovered by J. F. Bacon, Esq. Bengal Medical Service, in an excursion which we made, with the intention of profiting by the discovery of the shell next to be described, and which was obtained by drawing out water plants from a stream, and carefully examining their stems and roots. The first specimens taken I pronounced, when on the ground, to be merely a distorted variety of a young Lymnæa Chlamys, which occurs of a large size, though sparingly, in the same water; and the variety of Lymnæa Peregra, figured as No. 101, see Plate XI. of Gray's edition of Turton's Manual, was calculated to confirm the idem; but the sinistrorse volutions, and an examination of the animal, and its habitation under a lens, quickly dispelled the idea; and an abundant supply was obtained by us in a few morning excursions to the same spot. Other similar bodies of water, one of them parallel to this favored one, and not distant from it one hundred yards, failed to present us with specimens of the new genus. We considered the discovery the more fortunate, as it was our intention to visit another water, and the accident of finding the place of our intended search occupied by travellers was the sole cause of our examination of the spot which afforded us so much satisfaction. We here also re-discovered the new Trochiform, Planorbis, which we had taken at Bhimtal, and this shell was similarly deficient in the other waters of the neighbourhood.

Fam.—TURBINIDÆ.
Sub-Fam.—MELANIANÆ.
Sub-genus.—TRICULA, Nobis.

Testæ spirâ elongatiusculâ, aperturâ obliquâ, ovatâ, integrâ supernè angulatâ; peristomate continuo, subreflexo; anfræctu ultimo subumbilicato.

Animal. Melaniæ simile, proboscide elongatâ, anticè emarginatâ, tentaculis filiformibus duobus oculos posticè prope basin gerentibus; pede mediocri ovato, anticè subquadrato. Operculo corneo subspirali.

T. Montana. Testâ olivaceâ ovato-conicâ, anfractibus sex rotundatis, suturis impressis, aperturâ intus albidâ, peristomate nigrescenti; apice obtuso, plerumque decollato.

Hab: In rivo, apud lacum Kunavurensem Bhimtâl dictum.

This little shell I first found adhering to the prone side of a floating leaf of a species of Potamogeton, in a clear and weedy stream running through a marsh at the head of Bheemtâl, and supplying that lake; and subsequently Dr. Bacon and myself found it abundantly on the stems of a water Iris which we drew up by the roots, from the bed of the stream for examination. Accompanying it I discovered a few specimens of a shallow Ancylus,* and of Planorbis Calathus,† of which Dr. Bacon had observed dead specimens under stones, in the marsh between the old Buddhist temple and the lake. Among the roots were also a species of Pisidium, and a single dead specimen of a large and delicate Succinea, very similar to the European S. Pfeifferi, and nearly related to a species taken in Afghanistan by Capt. Hutton.

Tricula appears to connect the genus Paludomus of Swainson, (consisting of Melania conica, M. Stephanus,‡ &c.) with the more typical Melaniæ. It resembles the former in its thickened inner lip, while by the proportion of the spire to the aperture, and in its decollated apex it approaches some of the types of Melania. Again, its affinities shew a tendency towards Paludina in form? and in the continuity and incrassa-

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* This is the second species observed in India. Capt. Hutton found an unique specimen of another species some years ago at Bolundshehr, in the Doab of the Ganges and Jumna.

† Nearly related to a species found in Bengal by Dr. Cantor, and to another species from Chusan. It is however easily distinguished by the circumstance of its being furnished interiorly with series of toothed ridges at irregular intervals. A similar, but more regular structure, has caused several Naturalists to describe the European species P. lineata, under the generic name of Segmentina, after Dr. Fleming. I have elsewhere (Chusan Shells) adduced reasons for rejecting that supposed genus. The structure of the species under consideration will tend to confirm them.

‡ Jour. As. Soc. vol. v. page 747.

tion of the peristome. The inner lip is also reflected over the imperfect umbilicus, (a part which has no existence in any other species of the Melanianæ,) and is not merely a thickened plate, without any defined outer edge, adhering to the previous whorl, but is distinct and prominent, as in adult specimens of the most typical Paludinæ.

MORADABAD, *24th August*, 1842.

Rough Notes on the controversy against Geologists, carried on by those who adopt the meaning which was formerly assigned to the first chapter of Genesis. By ANDREW ROBERTSON, *Medical College, Calcutta.*

The geologist, while aiming at the discovery of truth only in the way in which all the other investigations of science are conducted, and by means of such evidence as can alone lead to sure philosophical inductions, has no little reason to complain of the treatment he has received from those who calling themselves Christian, have yet not displayed towards him much of the chief Christian grace, that of charity. Though completely ignorant of the state of the science of geology, and of the nature of the facts on which it rests, many of these have not hesitated to lavish on him what is equivalent to the epithets of blasphemer, infidel, and child of perdition. In numerous instances this ignorance has been traced to a wilful cause, for it is known that such have turned away from excellent opportunities of making themselves acquainted with the works of the God of nature, as if these could irresistibly induce conclusions contrary to the dicta of the God of revelation. But as ignorance is not now held to be the parent of devotion, such censurers, if they wish that the weight and respectability which may be attached to their opinions on matters in which they are conversant should be retained on geological subjects, must maintain their ascendancy by acquiring some knowledge of such studies themselves, not by denouncing those who are possessed of it.

But why should the geologist alone be exposed to such vituperation; why not attack the astronomer, the geographer? The Scripture information regarding Astronomy certainly is, that the earth is the principal body in the universe, to which every thing else has been created in subserviency; that the sun and moon are two great lights to enlighten it; that the stars are to adorn its sky and mark its seasons; that the earth is stedfastly at rest while these move around it; and that there are stores of water above its firmament, through apertures in which when opened, these descend to give it rain. The Scriptural idea of Geography is, that the earth is an extended surface, having ends or terminations; that it is established on the floods of water, or seas; and that it is supported on pillars. How do the notions of modern astronomy and geography tally with these? Why are they taught to the young? Why are not the astronomer and geographer counted to be as guilty of infidelity and impiety as the geologist? Is it not because men are accustomed to such contrarieties, having been taught the rudiments of these sciences even from their childhood? It is said that the Bible was not intended to teach men astronomy or geography; nor are they, in an age of improved science, bound to abide by the crude views of the age in which Scripture was written. Is the geologist alone to be an exception to this rule, and to be tied down by what has been supposed to be the literal meaning of every word in the Scriptural account of creation?

Again, the account of creation occupies one page of the numerous pages that make up the Bible. It is short, concise; often somewhat poetically expressed; written in the dramatic style, and not so clear as to have precluded discussion concerning its meaning long before geology was heard of. The Bible, in its whole tenor, and through its whole extent, has principally in view the making of men wise unto salvation; and when taken in its spirit and connection, it is wonderfully clear on all doctrines tending to elucidate this great point. Yet, by mangling the Scripture into verses, half, and quarter, and smaller portions of sentences,—a process to which no other book has been subjected, and which no book whatever will bear if the object in view be the attainment of its true import;—and by pitting one of these subdivisions from one book against a mangled bit of another, men have most ingeniously contrived greatly to obscure and perplex its meaning. Thence the most vital doctrines, even those with which the Bible is filled in every part, have at one time or another, become the subjects of argument. The divinity of our Lord; the nature of the sacrifice he offered up; its atoning efficacy; the cause of justification in the sight of God, whether by that sacrifice through faith, or by the works of men, or by penance; the work and influences of the Spirit; the extent and operations of grace; original sin; predestination; election, or the contingency of the determinations of the Deity upon the actions of the creature; free-will; the efficacy of ordinances, whether depending upon the valid ordination and intentions of the administrator, or the disposition of mind of the receiver; the head and order of government of the church of Christ. All these, and many more, bearing on man's spiritual state, on which the Bible has been avowedly written to enlighten him, have been, and still are, deeply controverted. Yet to all those who do so, the right hand of Christian fellowship is to be extended as to brethren in the Lord, though erring in some points; but the geologist is to be measured by another standard. If he dare to differ in any one supposed point from the succinct geological account given in the one page, even though he can produce the most overwhelming evidence for doing so, and even though the Bible has not been written to instruct men in geology, he is to be treated as a man devoid of religion, lying under the decree of reprobation, and led away by the instigation of Satan to do his work in misleading mankind. Is this because men have been for ages familiar with even the most startling points abounding in religious controversy; while geology is the offspring of the present age?

The pressing of Scripture into the service of any particular hypothesis in physical science, which men, according to their interpretation of its very concise and general language on such subjects, imagine to be maintained in it, is thus a proceeding on many grounds much to be regretted. Its most obvious effect is to place most unwillingly men of great powers of mind in the observation of nature, and in close and consequent reasoning upon the facts observed, in a position of supposed hostility to the Scripture. This is a sequence of the vague and inconclusive manner in which certain passages of it have been for centuries understood, chiefly, however, through the medium of a translation of these passages, biassed towards the preconceived opinions of the translators, which were in accordance with the philosophical notions of the times in which they lived. In this position the Christian geologist is surprized to find himself; and though it is too true that there are infidels among geologists, as well as in every other walk of life, yet such infidelity, he avers, does not necessarily flow from the study of that science, or the reception of what he must consider to be its demonstrated truths; and the stigma of unbelief in such a strongly accredited revelation as the Christian possesses he casts from him with indignation. If he has at all studied the Bible, he may even be able to give more and better reasons for the hope that is in him, than many of those who thus attempt to fix upon him such a stigma, for, in addition to the evidences usually detailed in every book on the subject, he may, with the grasp of a philosophical mind, see, proceeding on from the beginning downwards through a series of many centuries of years, the great plan devised by God for the restoration to purity of nature and happiness of his rational offspring, who had sunk themselves into degradation of moral character and misery through sin; and he can see the development of that plan, under the pens of numerous successive writers of various temperaments of mind and views; with such marked allusions to the manners and events of each passing age, and in such dialects of language too, as render the date of each successive book impossible to be mistaken. In the whole, there is apparent to him that singular moral phenomenon in the history of man, a connected series of steps of the plan evolved one after another in these distinct writings through the lapse of so many ages, downwards nearly to the time of the full completion of the revelation in the perfect light of the Gospel of our Lord Jesus Christ. This he considers justly to be irrefragable evidence that these men wrote, not of themselves, but moved and guided by the Spirit of God, for on no other supposition can the unity of purpose in such a long series of writings be explained. These writings, now collected, form the Old Testament of our Bibles, which is too apt to be popularly looked upon as one book only, and thus to loose much of that weight which its character, as a collection of books of widely remote times, would impart. That these writings are authentic, there is also to the man of a philosophical mind evidence of the strongest kind, besides that which is vulgarly received; for in addition to their styles and contents, he can perceive a standing miracle setting forth their truth,—the Jews, preserved as a distinct people until the fulness of Christianity shall overspread the earth, as witnesses to the Divine origin of their law, the heavy yoke of which, though once forced upon them, a reluctant people, by direct prodigies from heaven, they now cling to and venerate. They have watched from the first, as vigilant guardians of the purity of the text of all the sacred writings relating to that law, that no interpolation in them might be suffered either from among themselves, or from the hand either of Christian or of infidel. Yet, irresistible by every thinking mind as such evidence is, had some, who call themselves geologists according to Scripture views, the power, which they have not, to stake and peril the credibility of Scripture upon the meaning they give it, such is the weight of the physical evidence against these imputed meanings, written in the solid rocks from long by gone ages with a pen, the traces of which are indelible, that the authority of the Scriptures, high though it be, must have fallen before it.

If such men, then, by the promulgation of their peculiar views, make infidels of those who, though knowing somewhat of geological evidences, know but little of the Scriptures, never having studied them, and never having been grounded in the faith, and who otherwise might have found that peace which is in Jesus, of whom is such a result to be required? Is it not rather then, a gratifying thing for the Christian to find, that such views as their's are baseless and unsupported by any thing like evidence, and to reflect that when Scripture is thus wrested to an illegitimate use in attacking the deductions of science on subjects on which Scripture was not intended to give information, that such an attack recoils on its authors only, without affecting either the authority of Scripture, or the evidence upon which that department of science may rest; provided always, that the theorists in science studiously avoid, which it is not difficult to do, collision with the very general language in which all such subjects are touched on in the Bible. Should any infidel *savant* attack Scripture through science, he also errs, fearfully errs; for he cannot, like the other, plead purity of motive; and then, but not till then, it becomes the duty of the Christian geologist to bring Scripture into the field, into the discussions of science, and as he can do, if he knows the high position he occupies, strenuously and triumphantly repel the assailant. Yet still it does not become any Christian to condemn any science, because it may have been put to abuse; for it is God that giveth wisdom to the wise, and knowledge to them that know understanding.

In answer to some objections made against the language of some particular passages in Scripture, seemingly at variance with the mathematically proved truths of natural philosophy, it is now generally admitted, that in all such passages, and on all such subjects, Scripture speaks according to the ideas regarding them prevalent in the age in which it was written, or according to their appearances; that it was intended for one great purpose only, to be the guide of man in spiritual things; to make him aware of his position in this life, brought about by the introduction of sin into a world originally good; and to instruct him in the manner in which he may regain his lost happiness, and the favour of his God, by compliance with the means for that purpose therein detailed and pointed out. While this is dwelt upon and explained with the utmost clearness, even to the meanest capacity of intellect, all other things are slightly touched on, or alluded to in illustration merely, and not a few things of this passing incidental character are now unintelligible through our ignorance of ancient manners and events. The Scripture reveals moral truths, and on these it is a safe and certain guide; but it was never intended to teach even the principles of physical science. These it leaves, just as it found them, in the state of elucidation to which the intellect of the age had brought them, contented with expressions which are so worded as to be in accordance with the ideas of its times, and yet not in contradiction to any discoveries by which the research of man might afterwards fill up the outlines of such a general sketch. The finding out of physical truth has been left by it to the unaided intellect of man as a fitting subject for its exercise, and nobly, in many instances, has that intellect fulfilled the task thus assigned. Different, however, was the case in regard to moral truth. That was too momentous to be left to man only, since his eternal happiness or misery depended on his being aright informed of it; on it therefore, but on it alone, an inspired revelation is given fully, as a sole and infallible direction to the happiness of the blest.

It may be asked, Why was this so, why was not a full and correct theory on such subjects as astronomy and geology given? In reply to such a question it may be inquired, what relevancy would such theories have had in relation to the great object in view,—the elevation of man from the depth of sin and moral ruin, to a renewed holiness of nature, and its consequent happiness. The foolishness of God is wiser than the wisdom of men, and it is just another proof of His wisdom where the intellect of man would go astray. It needs not much penetration to discover that had this been done, it would have been an obstacle to the reception of a Divine revelation containing it, until man had made a proficiency in science sufficient to appreciate such truths; and that, after he had made this proficiency, it would have stamped, in the opinion of many, that revelation with the strongest mark of a literary forgery; viz., the development in it of facts and opinions, the growth of an age far more recent than that in which it purported to be written. How does the matter in reality stand? The passages in which sciences of research are touched on are so worded, that while not at variance with the notions of the most illiterate period of the world, neither are they, nor can they, if properly taken, be in opposition to the conclusions of the highest learning of the most refined.

The impropriety of setting passages of Scripture in opposition to the conclusive inductions of sound science, is well exemplified in a historical fact. When the light of the present system of astronomy first dawned upon the world as an antagonist to that philosophy which held that the sun revolved round the earth, it was decided by the

Scripture astronomers of that day, men as learned, according to the learning of the times, and as wise in many respects as the most of those of the present, that such ideas were fully refuted by such texts as are mentioned below,* that it implied infidelity of the Scriptures, and was a damnable heresy, and that Galileo, who maintained it, was most leniently dealt with in being imprisoned only, instead of being burnt alive. No one of the present day, however devoted to Scripture views of philosophy, ever dreams of questioning such mathematically demonstrated truths; and a good reason is given for belief in them, even though seemingly they are contrary to such texts as have been quoted; viz., that the Scriptures are not intended to teach us astronomy, but merely speak in these passages according to appearances to the senses. The days are not far distant, and it requires no gift of prophecy to forsee it, when an answer similar in import must be given in regard to the passages supposed, though supposed merely, to contradict the equally certain, and almost equally demonstrative truths of geology; or, if the adherents to certain hypotheses persevere, as they are doing, in pressing it on to the awful arbitrement, with many the physical evidence of geology will be put in the balance against the moral testimony supporting revelation, and, particularly in our own days, when men are adding to the pure law of God ritual and superstitious observances of their own devising as a part of it, the question with many will be, which of the two is entitled to the greater credibility.

A very few facts also, in regard to interpretation of the Scriptures, where they do not bear upon matters essential to the salvation of mankind, on which point they are always remarkably full and plain, might serve to teach a little caution to Scripture geologists, in laying such stress on detached passages and words, written in a language in some

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* Ps. civ. 5. Job ix. 6. Josh. x. 13. Ps. xix. 4, 5, 6. Eccles. i. 5. Ps. civ. 19, &c.

respects imperfectly understood. What can appear more beautiful, perspicuously told, or feelingly expressed, than the episode in them of Jephthah's daughter, and yet a learned controversy, on which volumes have been published, exists, and is undecided to this day, whether she was made a burnt offering, or merely became a nun, turning in a considerable measure upon whether one little Hebrew word in a passage of it signifies 'and' or 'or'; and whether another is to be taken in its sense of 'talk with,' or 'lament.' In many places of the Bible, too, the translators of it openly admit their ignorance of the meaning of words, though it is remarkable that this is only in objects of natural history, or in obscure allusions to ancient customs,—things of no consequence to the elucidation of its great doctrines. Take, for instance, the original words retained, gopher wood, shittim wood, algum or almug trees, &c., a list which might be much enlarged. It is precisely in such passages as those that bear upon the geological controversy that misunderstandings of this kind may be expected. Take for example, the beautiful expression of which Milton has made so much, "The Spirit of God moved upon the face of the waters;" and although the poetry of it be destroyed by a change of translation, does it not give us a more dignified idea of the Supreme Being in working his will by secondary causes, rather than by direct intervention, to say there was "a most vehement wind moving," (or a great commotion,) on the surface of the elements of the present world. This appears to be the preferable translation; for though, in the original, the definite article is prefixed to the words rendered heavens and earth, and to others, it is not prefixed to the word here translated *the* Spirit, and the insertion of the "the" is purely gratuitous; the same word signifies wind or breath as well as Spirit, and the word, literally translated "of God," is also the highest form of the superlative in degree, and has actually been so rendered in Psalm lxxx. 10, where "goodly cedars," are literally cedars of God; and in Acts vii. 20, where "exceeding fair" is in like manner in the Hebrew-idiomatic Greek of the original, fair to God. It is not also difficult to trace in the English version of the account of the creation of the world, a tinge of the Greek philosophy received at the time when the translation was made. Thus the word rendered "firmament," literally signifying something expanded or spread out, is made to have too great affinity to that sphere of crystal in which the heavenly bodies were then said to be stuck and carried round; and perhaps in such a matter relating solely to what was physical, while the account of the origin and fall of man is the dictate of inspiration, even Moses may have been left by the Holy Spirit, at liberty to use the ideas of the Egyptian philosophy, in which he, and doubtless others of the Jews were well versed, and which is generally understood to have been nearly identical with the Grecian of after-ages.* Under all these circumstances it is evident, that though the general scope and meaning of such a series of books as composes the Bible cannot possibly be mistaken, it is very possible that an argument founded upon the connection, construction, or interpretation of words in a few detached sentences, may be valueless, simply because the premises on which the basis rests, and the whole of the reasoning is reared, have no existence in

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* Traces of the Grecian, once Egyptian philosophy, may be found in many other places of Scripture. Such are the expressions of "the windows of heaven," *i. e.* of the crystalline sphere, "being opened," that the waters above the firmament might descend in rain; of "the pillars of heaven," and of "the earth being founded on the seas and established on the floods." To shew that this permission of the Holy Spirit to the sacred writers, to use the philosophical ideas in vogue at their day, just as in other places they speak according to appearances, not according to realities, is not so very unlikely, it may be mentioned that St. Paul even quotes a verse of a Greek heathen poet, which thus becomes a text of holy writ.

the original document. Should the argument depend upon such words in the translation into a foreign tongue, as "but," and, "or," &c., or upon whether a member of a sentence is to be read along with what precedes, or what follows it, though such a mode of reasoning may be allowed in removing alleged contradictions, as proving an affirmative, it is worth literally nothing. He who builds his arguments upon mere verbal niceties of passages of Scripture, is perhaps not aware of the formidable list of various readings which exists, causing uncertainty, or at least giving rise to the suspicion of it, in regard to the petty words upon which he founds. If he trust to an English translation, so much the worse, for in addition to mis-translations, and possible slight errors in the original text translated from, there is a source of petty mistake in the printed copies of that translation, which, when the question of the Bible printing monopoly was agitated, were shewn by comparison of editions to be more disfigured by gross typographical blunders than almost any other book. At the same time, however, it is admitted, that none of these various readings or mistakes seriously affect the general sense of the whole.

It has been contended by some, too, that the Scripture ought always to be taken in the sense in which it was understood by the writers of it. This, which would at once bring Scripture into collision with several sciences, though a good rule in regard to merely human writings, involves a fallacy as applied to holy writ. There, there are two authors of the work, the mere agent who writes, and the higher being, the Holy Spirit inspiring him. It is easily seen that the superior intelligence may have intended to convey to after-times, under the words, a higher and more extended meaning* than was apparent either to the inditer, or to the men of his

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* John xi. 49—53.

age. Such are the words of prophecy; such more particularly are the prophecies which have a double accomplishment in the type and antitype; and it does not seem unreasonable to suppose, that the mysterious language in which the future is shrouded, should also cast its veil over the obscurity in which the commencement of time has been involved.

It is a great mistake in men, otherwise possessed of much information, but who have not studied geology in its recent state, to imagine that it is what it was some thirty years ago, a mass of contradictory statements, on which geologists disagreed, and were perpetually wrangling. Were it so, it might merit their neglect or contempt. But Wernerians and Huttonians, alias Neptunists and Plutonists, have long since retired from the literary arena to repose in the receptacle of the vagaries of Whiston and Burnet; the better parts of both their hypotheses being blended into the present system of inductive geology. Of that geology there are certain great principles and leading facts universally admitted by all who are conversant in the science, and these are numerous, very numerous indeed, in proportion to such as are still controverted on feasible grounds. The present division of geologists into those who suppose that the alterations upon the earth's structure in by gone times have been caused by sudden and violent convulsive or eruptive action, and those who are the advocates of the hypothes is of gradual change, will, like that of Wernerians and Huttonians, likely soon terminate in a union of forces; for both appear to be so far right in the views they maintain, and err only when they deny or exclude altogether those of the others; for there is sufficient evidence to shew that certain portions of the earth's surface have been tranquilly formed, and that others could have assumed their present appearance only under the influence of the most violent, extended, and sudden convulsions. Geology has become a regular science, in fact just as much so as chemistry is, and rests exactly upon the same foundation; viz. the changes which matter undergoes under the power of certain re-agents; and its recognised properties depending on the certainty with which, under similar conditions, these changes are similar. From this, in chemistry, results may previously be philosophically inferred from causes or processes; in geology, by a reversed mode of reasoning, the causes or processes are judged of from an examination of the products.

If it be alleged that the discoveries of geology receive no countenance from Scripture, it may be answered, neither do any of the other discoveries of science. It speaks of the heavenly bodies and their motions, but where is any trace in it of the demonstrated truths of modern astronomy. It speaks of the four anciently supposed elements, but, excepting in the incidentally mentioned action of vinegar upon nitre (carbonate of soda), and in regard to the familiar phenomena of fire, where in it is any vestige of the established facts of chemistry. It speaks of the seas being measured, and the mountains weighed, but where in it are any allusions to the present demonstrated system of geography, or the mathematical foundation on which it rests.

After these remarks, we may notice some of the geological hypotheses, which, while they are in accordance with the evidence from which geology deduces the changes which have formerly occurred on the surface of the earth, can yet be satisfactorily shewn not to be at variance with the very concise and general account of the creation given in the Bible.

In reference to these hypotheses, the following statements, generally admitted by geologists, and believed to be correct, may be made.

There is no foundation, either in Scripture or in geological data, for the supposition, that a geological revolution was consequent upon the moral fall of man. The ground was merely cursed with barrenness, and with a tendency to produce noxious and troublesome weeds; a curse since then denounced* and executed, on account of the sins of the inhabitants, against Judea and other lands, once the most fertile of the earth. The omission of any notice of such a revolution in the sacred pages seems quite decisive upon this point, especially when we see in them a most detailed description of a lesser geological change, that in which the cities of the plain were destroyed by a miraculous eruption of fire, and their site converted by the subsidence of the ground into the bed of the Dead Sea.

Similar to such a baseless idea is the common and poetical one, supposed to be derived from the Scriptures, that death, in any shape, and among any class of beings, was unknown in the world before the fall of man. We need not say that nothing on this point can be legitimately deduced from Holy Writ; for that refers solely to man, the anomalous connecting link between the material and spiritual worlds, and partaking of the nature of both. Geology shews decidedly, that, long before man was created, certain living beings ceased to exist on the earth just as they do now, and that such a destruction of life was contemplated even, and formed a part of the great plan, as the races of animals, necessarily carnivorous, were fully as numerous then as they are now.

The deluge of Noah's era, though cordially received and admitted by the geologist upon the authority of Scripture, and as an important event in the moral history of man, is in a geological view, of no interest; the traces left by it being insignificant in comparison of those made by previous great currents of water. This, from the relation in the Bible, was to be expected. Its continuance on the earth was short; and it was not a violent rush of waters, but a gradually

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* Deut. xxviii. 23.

increasing and subsiding movement, which left the olive leaf to the dove uninjured; which probably spared the germs of vegetation; which bore up the ark in safety, though of a size which, according to the result of the late Canadian experiment of the two large timber ships, would have been strained to pieces in an agitation of the waters, through which a smaller vessel would have passed undamaged.

There is no geological evidence of the existence of man or his works upon the earth, at an era anterior to the present by more than 4000 years. The Scriptures assign a date usually supposed to be about 6000 years ago, for the time of man's creation. In this, therefore, the most material of all the facts bearing upon the question—in as much as the whole of the Scriptures are avowedly written not to give an account of the mode of existence of things, or of their origin, but of the origin of man only;—of the cause of his moral degradation through sin, and the remedy for this degradation, through which he may be restored to the high position he once occupied in the moral creation; in this most material, then, of all the questions upon the subject, it may be fearlessly asserted, that the doctrines of geology and of the Scriptures are in perfect harmony.

But while there is no trace of the existence of man prior to the period of the most recent tertiary formation; there are most numerous previous deposits of immense thickness, which, according to the lowest calculation, it must have required millions of millions of years to produce, and in these are imbedded vast quantities of animal and vegetable remains, reaching back in a succession of the most varied, and often dissimilar, successive forms, through groups of bewildering number and extent. Nay, there are even enormous rocks and stratifications, composed solely of debris of organised beings once endowed with vitality, in such multitudes, that it is difficult to conceive how the earth could have supported and reared them, even in the time, protracted as it is, which geology infers to have past while the deposits containing them were made. It is certain, even if the thing were not otherwise absolutely impossible, that, owing to the infinite individual number of these fossils, there is no feasible mode of accounting for the strata containing them coming into existence, nor for the repeated emersions from, and immersions into both salt and fresh waters which these strata have been proved to have undergone, during the 6000 years since man's creation, without the most uncompromising and flagrant departure from the pretty strict and limited chronology of the Bible, an offence surely as grievous as going in the teeth of the statements of the Bible in any other way. There remains, therefore, only the supposition, and it comes backed by the most overwhelming and crushing mass of evidence, which may be found in detail in any good elementary work on the subject, that the world, both in its form, and in a great measure in its present structure, existed long, even ages almost countless by the finite understandings of men, before man himself had any existence upon it. Neither does this supposition either contradict the Bible account or assert any thing at variance with it; for the Bible pretends not to give a history of the revolutions on the surface of the globe, it merely relates the moral history of man.

There is, however, one supposition, and one supposition only, but it is such that it requires the mind to be peculiarly constituted to adopt it, by which every difficulty is at once removed, the knot is cut, and every possible geological appearance is brought within the limits of the time which, in popular opinion, is assigned by the Scriptures for the duration of the very materials which compose the earth. It has the merit of being the only tenable ground on which they who hold this popular opinion can stand; and from it they can never be dislodged. It is this, that as God tried the faith of Abraham, David, and others, in his promises, by apparent impossibilities to the execution of these; so he created the earth with all its present appearances at once, and at the first, for the trial of the faith of its inhabitants, whether they would rely in preference upon the moral evidence supporting his revealed word, or upon the evidence of the senses and faculties with which he had endowed them for judging of these appearances, according to the laws under which matter is found to act, and be acted on, in the usual course of his natural providence. This supposition is just within the limits of possibility, certainly beyond the verge of probability; for, though God may often try those who are his in severe moral discipline, whether they will believe in his word even against hope; it seems most unlikely, that he would thus lay for men a perpetual stumbling block in the contradiction between the work of his hands, and the contents of the revelation in which he requires an undoubting faith.

There are, however, two systems or hypotheses yet to be brought under review, on which all the general appearances may be satisfactorily accounted for, in a manner which is in accordance with geological evidences, and yet not at variance with the words of Scripture when properly understood, far less in absolute contradiction to them, as has been often asserted. One of these proceeds on the assumption that the Scriptural account of creation includes the whole period during which the world we inhabit has been in existence, and has been a place of abode for animated beings of any description; but it asks as a postulate, that the days of creation shall be held not to be strictly and literally days of 24 hours only, but every one of them to be a period of great and unknown length, the evening and morning of which, according to the eastern mode of computing the day, or morning and evening according to European custom, metaphorically, or rather according to the poetical style of eastern language, denote the beginning and ending. Such a sense of the word day is understood by theologians to be not unusual in the Scriptures. The ordinary use of day, as meaning year in prophetical language, is well known. For particular instances, Christ himself speaks of the three and half years of his public ministry, as his day in which he must work; of the period of God's forbearance with the Jews, as the day in which they might have known the things belonging to their peace, which undoubtedly extended over a very considerable number of years; and of the Patriarch Abraham rejoicing to see His day afar off, meaning the day of the Gospel dispensation of grace and love to man, which has already lasted upwards of eighteen centuries, and, if the interpretation of very obvious prophecies be just, will yet endure till the inhabitants of the earth become Christian, and a thousand prophetical, or 365,000 common years besides. Of each of these days, the leading or characteristic work only is mentioned; but this does not necessarily imply that a farther creation, of a minor or subsidiary kind, did not take place along with it in the same period.

The second hypothesis supposes that, according to prophecy, there shall hereafter, by a tremendous convulsion, be a great change upon the surface of the earth and the beings upon it; and infers, both from this analogy of Scripture, and from geological evidence, that several such convulsions have preceded the presently existing state of things. Both of the hypotheses agree in dating the era of Scripture chronology from the origin of man, the latest work of the creation; and both also unite in requiring an immense indefinite lapse of time, between the first creation of the materials of the system which we inhabit, and man's first appearance as a part of the creation. Should this point be conceded, which there seems to be nothing in the Scripture to prevent, geology becomes the handmaid of revelation, assisting it and confirming all its statements. Should it be denied, and the hitherto common opinion, though seemingly not fairly deducible from the words of Scripture, be persisted in, that a few days only intervened between these events; whoever does so, does what in him may lie at once to bring to issue the relative weights of the material evidence supporting geology, and of the moral evidence of the truth of revelation. On this the whole question hinges, for undoubtedly lapse of time, even to the extent of countless ages, is the one prominent and indelible feature impressed upon the geological structure of the surface of our globe.

In filling up the very scanty outline of the sketch of creation given in the Scriptures, much must be left to the exertions of fancy. Still there will be found much for which there is a solid foundation in the received facts of geology, astronomy, chemistry and mechanical philosophy.

According to the first of the hypotheses which have been noticed, it may be assumed that, in the beginning, the materials only of the earth and solar system were created; and that upon these were impressed from the first those laws by which the visible creation has since been found to be regulated; by the continuous effect of the operation of which, the whole was gradually wrought into order and beauty. Herschel has found nebulæ in the heavens, vaporous bodies apparently condensing into systems like our own. Let us suppose, what is in no view improbable, that our solar system was formed out of such a nebula, an immense mass of vaporous matter, filling a space larger than the orbit of the remotest planet. Suppose farther, that this vapour, at its first existence by the fiat of creation, was in an intensely heated state. Let us now consider what, according to the known laws to which matter is subject, would follow upon this, and how these consequences would tally with known facts. The most intense heat with which we are acquainted is that produced by the oxy-hydrogen blowpipe, and, when the hydrogen is free from foreign admixture, which however it is very apt to contain, in consequence of this extreme heat the flame is invisible, all being so thoroughly vaporous as to hold in it no solid minute particles to throw out light, which, it has been proved, that all flame or other aeriform heated bodies must do, before they can be luminous. The original materials, then, being so intensely heated as to be in this completely vaporous state, they would, according to the description of Scripture, be without form, and seemingly a void or emptiness, and they would be dark, wholly devoid of illuminative power.

It has been proved incontestably by the experiments of Wells, Leslie, and others, that the earth,* and by analogy the other bodies of our planetary system, part with their heat by throwing off or radiating it into the regions of space; the nebula therefore would gradually cool at the outer surface, different parts of it would come to possess different specific gravities, as we observe in our atmosphere; thence would arise a commotion or rushing among its parts; in the language of Scripture, a wind of God, or mighty wind. As these currents of vaporous matter would necessarily be stronger in one direction than in another, the whole of the nebula would at length begin to move in the direction of the most powerful; it would assume a circular gyrating form, like a whirlwind, or a vortex of water; and from this would originate that impulse which now causes the planets to encircle the sun in their courses, and to revolve upon their own axes.

In consequence of continued progressive cooling, the less volatile matters would begin to separate from the vapours and gases in minute particles of solid matter. Then bright and intensely increasing light would appear, just as may be shewn by throwing a fine powder through the invisible oxy-

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* It was we believe the French Philosopher M. Fourier, who first demonstrated all the laws of heat here referred to. We insert with our extracts an abstract of M. Fourier's results, as a striking example of the beauty and simplicity of his mathematical demonstration of the general laws of heat, with which we cannot be too familiar.—Ed.

hydrogen flame, or by burning, in place of the pure hydrogen, a carburetted hydrogen (oil gas, for example,) which, on being heated, deposits its carbon in a pulverulent form in the flame. In the language of Scripture, "there was light." This light would be a defined body in the midst of the surrounding primæval darkness; it would be divided from the darkness, forming the distinction between day and night, and marking the first period of creation.

This light would not at first pervade the whole mass, but would appear at the place where the greatest cooling effect was predominant. Here the solid matter would condense to a centre, the globe of this earth would be formed, consisting, as, on probable evidence, it is at present supposed to do, of a large sphere of ignited fused matter in the centre, beneath a comparatively thin crust produced by refrigeration at the surface. As the temperature fell, the vapour of water would condense around this into a uniform ocean; the term waters, in a previous verse, seeming not to be applied to this collection of waters, but to the vaporous fluid of the nebula, just as the word fluid may signify in its extended sense, either a liquid, or a gas, or vapour. This ocean would be surrounded by the atmosphere, (the heavens, expanse, or firmament), by which the waters condensed around the globe would be divided or cut off from those that were still in those parts of the nebula which were uncondensed. This would be the second period, during which the stratified primary rocks would be deposited, and also the transition; during the latter part of which, though the creation of these be not noticed in the Scripture, the remains shew a few corals, shell fish, and fishes, to have existed in the surrounding ocean. Clouds would appear in the atmosphere in this epoch.

The contraction of the crust of the globe by the cooling agency of radiation, and the deposition of water upon it, would now, according to the law found to prevail in almost all bodies cooling down upon the earth, reach such a degree of tension, and in consequence so confine and press upon the melted matter below, as to cause that to break through it in numerous fissures, and to rise to the surface by that pressure, forming the greater part of the igneous primitive rocks; the strata, by its passage would be disrupted, torn up, and thrown into different angles of inclination, especially as the commotion would be increased by water penetrating to the fused mass, and the evolution of vapours and gases to which this would give rise; a phenomenon which would be repeated also at intervals, as the effects shew, in all the other periods of the earth's history. By this the earth was heaved up above the level of the waters, a bed depressed for the reception of the ocean, and the mountains were upreared. This was the third period of creation, during the first part of which the deposition of the strata, down to the mountain limestone inclusive, was completed; during which there was in the ocean numerous corals, shell fish, and some fishes and sea weeds; and, during the latter part of it, a most abundant vegetation on the dry ground, owing apparently to a high tropical temperature over the whole earth, and an atmosphere too much loaded with carbonic acid (the principal food of plants) for land animals to exist in it. Hence originated, towards the end of this period, the coal formation, immense deposits of carbonaceous matter, now proved to be of vegetable origin, and still partially to retain the vegetable texture; and the coal measures, abounding in vegetable remains. This, then, was the epoch when, as mentioned in the Scripture, the earth brought forth grass, the herb and the tree so abundantly, as to constitute as it were, the peculiar reign of vegetable life in predominance over the rest of animated nature. During the whole of this period and the preceding, the earth may be supposed to have derived light and heat from a superior luminous atmosphere encompassing it, whether attached to itself, or a part of the condensing vaporous nebula; just as at present a luminous calorific atmosphere surrounds the dark body of the sun, and, through occasional partings in it, discloses that dark body within in the shape of opaque spots on his disk.

As the successive cooling down of the nebulous mass proceeded, a different order of things commenced, constituting the fourth period or epoch of the creation. Before this the temperature of the nebula has been supposed to fall at one point chiefly, around the centre of which was deposited the condensed matter forming the globe of this our earth; but then, as the caloric of the vaporous fluid became still farther dissipated into space, several other centres of refrigeration and deposit took place in it. The largest of these, nearly in the middle of the nebula, attracted to itself by far the larger portion of matter and became the sun; which thus, owing to the immensely larger quantity of the vapour which was condensed to form it, and the consequently much longer interval of time necessary to cool it, was of much more recent origin than the earth. Around other centres, towards the outer verge of the nebula, there were other condensations into the planetary bodies of the solar system and the moon, which last, coming within the range of the attractive influence of the earth in preference to that of any other of these bodies, became to it a secondary or satellite. This the Scripture speaks of as the work of the fourth day.

In giving an account of this hypothesis, the vaporous matter of the nebula has been supposed to have been condensed to its several centres of deposit, within the nebula, and in the globular form; and this view has been taken on account of its greater simplicity and seeming probability, and because several such different centres of deposit have been actually observed in nebulæ. Some have, however, preferred a different one. According to this, it has been thought more likely that the vortiginous nebula cooled and condensed equally from its surface towards one centre only, in fact towards the sun, the centre of the whole. Thus an immense sphere, semi-fluid without, vaporous and apparently hollow within, would be the figure assumed, still retaining the original motion, and revolving on its axis with immense and increasing velocity, until, as a rapidly turning grindstone or fly-wheel throws off from its rim whatever is not firmly attached to it, so, by the centrifugal force generated by this rotatory motion, superficial rings of the outer condensed matter would be successively separated from the great mass, and, by attraction, would collapse together to one part of the circumference of each ring, to form the several planets; with the exception of the ring pertaining to the orbit of the more recently discovered four little planets nearly equidistant from the sun, which, by breaking into four pieces, gave rise to them. The orbits of the several planets are thus commensurate with the space occupied by the spherical mass of the nebula at the time these were detached. The most remote planet was thrown off first and brought into shape, the others in their order, the sun, was formed last. Farther, the secondaries or satellites were thus generated from their primaries, which had a similar circular movement on their axes derived from a modification of the original nebular motion, in a precisely similar manner, with the exception of the ring of Saturn, which still remains a ring. This particular view of the nebular hypothesis is said to be supported by the reasoning of the higher mathematics, based upon the velocities and times of revolution of the several planets around the sun.

Which ever of the two views be adopted, the result is a remarkable one. The stumbling block of the sun not being created till the fourth day, which has perplexed and bewildered all Scriptural commentators on the account of creation in Genesis, is not merely at once naturally and satisfactorily removed, but is shewn to be a necessary consequence in a planetary system brought into shape by the working of the powers impressed upon matter by the Creator, and by the operation of which, he still governs and upholds the universe in its admirable order and beauty.

The creation of the sun, at this time, seems to have had immense influence upon the condition of the earth. Thenceforth the sun was to it the source of light and heat, its own luminous atmosphere appearing to have left it, and to have been, along with all the other permanently luminous and calorific matter of the nebula, attracted to that great centre of the system. This may be supposed to have happened through some action unknown to man, remotely analogous to that by which the subtile fluid, proved to be the source of electricity, galvanism, magnetism, and thermo-electricity, and on good grounds, thought to be the cause of heat and light, appears as heat and light, at the connecting series, poles, or electrodes of a galvanic battery, and in that part only of the circuit along which it passes. Thus the sensible energy is exerted at the sun alone, though the invisible cause of this circulates alike, but unperceived, through the whole of the planetary worlds which are his dependents, and the intermediate space by which these are surrounded. Or, the change may be supposed to have arisen more probably and simply by the cooling down of the luminous matter around the earth, whether that matter which had previously enlightened the earth was attached to itself, or was a more remote portion of the generally luminous and heated nebula, to a point below that at which it was luminous and calorific, and from a consequent absorption of the matter of the light and heat into a combination with other matter; from which it may still be eliminated at pleasure, by the means for producing artificial light and heat. In this case, the present darkness of all the planetary bodies, and the luminosity and heating power of the sun, may be looked on as in strict analogy with what happens in regard to heated bodies upon the earth.

The brilliant atmosphere of the sun may be a remainder, an uncondensed portion of the nebulous vapour collected around him, resembling the luminous vapour of lime in the pea light, cooled down to a certain stage only, in consequence of the much slower refrigeration of such an enormous bulk. If so, by the operation of natural causes in their ordinary course, and without any more direct intervention of Divine power, the time will come, when, by a slow but progressive farther cooling down, in the words of prophecy, the sun shall be darkened, and the reflected light of the moon shall not be given.

In consequence of the earth thus losing its luminous and heat-giving atmosphere, the distinctions of tropical and polar temperatures would be introduced upon it. A change would also likely ensue in the motion of the globe, greater or less according to what may be supposed to have been the nature of its previous motion. Thus the axis and time of its diurnal, the orbit and period of its annual revolution, may probably have been altered through the attractive influences of the newly formed bodies. Then probably commenced the present established duration of the day and year, for the sun and moon were for signs and for seasons, for days and for years, and to rule the day and the night. There would also be a modification and increase of the tides in the ocean by the change of direction in the attractive influences raising them; and owing to the alteration of its axis of revolution, and to the quickened velocity of its motion, the earth would assume its present form of an oblate spheroid, through the yielding of its crust to the centrifugal force of the fused matter beneath it. Thence would result enormous upheavings and dislocations of the strata, some of the greatest of which have been ascertained to have taken place at this geological period, additional and higher mountains and precipitous rocks, and, as a consequence of these commotions, and of the impulses given by the accumulating centrifugal force of earth, there would be mighty sweeping floods of water over many parts of the earth's surface; which observation shews to have taken place. Do not the higher elevation of tropical mountains, the lower general character of polar ones, the intermediate heights of those between, give countenance to the supposition of such effects of such a centrifugal force? During this period the magnesian limestone, and new red sandstone formations seem to have been deposited.

The fifth period requires no great extent of illustration. It was pre-eminent for the production of birds, of the inhabitants of the waters, and great whales. This may be supposed to have extended from the beginning of the lias to the end of the chalk formations; abundant in the remains of pterodactyles, saurians, fishes, and other inhabitants of the waters. During this the temperature seems to have been still falling.

The sixth period may be supposed to include the eocene, miocene, and older pliocene deposits. Then, the living creature, the beast of the earth, was created, as seen in the remains of the theria families, mammoth, &c., and, towards the end of it, during the deposition of the newer pliocene, came the present inhabitants of the earth, the creation being concluded in bringing man into being. Man is now under the seventh period, that of rest from creation, in which all shall remain as it is upon the earth, until the promised period of the moral and physical regeneration of the world shall arrive.

The second hypothesis, upon which the deductions of geology may be reconciled with the account of creation in Scripture, may be very shortly stated. It supposes the whole of the specific creation, as detailed, to have taken place in six literal days, as usually understood, and to form now the presently existing system of animated nature. But, to account for the immense quantity of organic reliques on the earth's surface, it supposes a most extended lapse of time to have intervened between the beginning, in which the earth itself was created, and that latter creation, during which several systems of animated and organised being were successively brought into existence and again destroyed. According to this, the creation of light, of the atmosphere, and of the sun and moon, mentioned in the Mosaic account, was more properly a restoration than a creation; in like manner as the then creation of organised being was in many respects a renovation of the same types of being as formerly existed. In so far as regards effects and practical results, this is evidently nearly the same as the other.

Though this view may not be directly supported by the words of Scripture, it is certainly not at variance with them; and though there are difficulties, it may yet reconcile physical appearances with moral doctrines as well as the other. The principal support it has is derived from an argument of analogy. According to the prophesies of Scripture, there shall be, in after-ages, a destruction of the things presently existing upon the earth by fire, which is described in such terms as to render it evidently a geological effect of subterranean igneous agency, and other causes connected with that agency. Thence it becomes probable, that, as we observe the marks of such igneous action in by-gone times outspread upon and over the surface of the earth, the organised remains of extinct species of being, under the soil and in the rocks, may have resulted from similar catastrophes of other creations.

This future great convulsion of the earth, by which the creation of organised being presently subsisting shall be destroyed, is described in a manner according with observed geological facts, and the phenomena usually accompanying earthquakes and volcanic eruptions. There shall be an alteration in the appearance of the sun, moon, and stars, and on earth the sea and waves roaring. The sun shall be darkened, the moon not give her light, the stars (electric or other meteors,) fall from heaven. A fiery stream shall precede the presence of the Lord. The heavens shall pass away with a great noise, the elements melt with fervent heat, the earth also, and the works that are therein, shall be burnt up.*

No language can perhaps better express concisely the geological disturbances which shall remove from the earth the being and stains of the present sin-polluted and misery-enduring creation of animated beings, to make room for that future one of which the marks shall be holiness and happiness. Smoke and vapour darkening the heavenly bodies and the face of the sky; horrible subterraneous noises and convulsive movements, commotion of the great body of waters, displacement of the rocks and hills, emission from below of many and copious streams of the igneous liquid matter there, which shall overthrow, melt, or burn all before it.

It is asserted, on incontrovertible geological evidence, that generally the lowest mountains are the most ancient comparatively, while those of more recent origin tower up the highest, and constitute the greatest ranges. This is what might be expected, for, during the progressive cooling and thickening of the crust of the earth, not only would eruptive action occur at progressively more distant intervals, owing to the greater accumulation of force required to lift the increasing mass above, but, when the movement did take place, it would be much more extensive both in surface and elevation. If we can conceive, then, the effects of such eruptions of fiery matter as were necessary to lift up the masses of the Alps, the Pyrenees, the Andes, the Himalayas, in comparison of those of the efforts expended on the smaller mountains of Britain, we may form a slight idea of

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* Luke xxi. 25. Matt. xxiv. 29. Dan. vii. 10. 2 Pet. iii. 10.

that tremendous and general convulsion, which shall overwhelm and alter the surface of the globe at the consummation of the present order of things; when, to gather strength for that last outbreak, the subterranean forces have been confined, and shall still be, for numerous ages beneath the solid vault enclosing them, till, at length, overcoming its cohesive power, they shall burst forth in a wide-spread, rending, and explosive eruption.

Such is an imperfect sketch of the hypothesis of successive creations, of successive destruction of them by igneous or aqueous action on the earth's surface, and of the chief argument by which such a view is supported. And this supposition of eruptive or cataclysmic action at remote periods, by which the greater part of animated being on the globe is destroyed, and is replaced by a new creation, consequent upon the direct interference of the Creator, is not merely not at variance with revelation, but is even supported and confirmed by it, and confirms and supports it in its turn. Ridicule has been attempted to be cast upon it by its opponents, by seizing on some verbal expressions, as if it were held that the world was supposed to be thus reduced to "a wreck," "a ruin," "a chaos," down to the very centre. This indeed would be absurd and most improbable, and contrary to evidence, contrary to fact. A cataclysm, or an eruptive convulsion of the earth, does not, in a geological sense, infer such an extent of commovement. With the exception of the submersion of one part of the earth's surface, the upheaving of another, and the extrusion of a comparatively limited extent of highly heated rocks in a fused state from below, it may even consist with but slight alterations upon the earth at its surface. It merely implies such an amount of the joint effects of the actions of fire and water as is sufficient to destroy organised being at the time, with the probable exception of such shell fish, &c. as might be sheltered from it in the recesses of the ocean, and so might continue the species in existence through another period.

Those geologists, if such there be, who, overlooking all the traces of sudden and violent action, rest their system solely upon the evidences of gradual change, a source of the observed appearances in stratification which their opponents also admit, but only conjointly with the other; who maintain that all things have proceeded in the same train, and in the same manner, as a consequence or effect of the same causes, in the same intensity, as are now daily in operation, and through no other; who hold that species, genera, orders of being become extinct in the lapse of time and are replaced imperceptibly, no one knows when or how; who suppose that the primary rocks, instead of being really primary, are metamorphic, secondary and tertiary altered and having their organic remains obliterated by fire, through their sinking deep enough to come within the range of the central heat, must answer for themselves. Their sin is not the sin of the science of geology, nor ought it to be laid to the charge of all geologists indiscriminately. It belongs to them to defend themselves, and to rebut, if they can, the accusation which may be brought against them on perhaps as fair inductive reasoning as their own, of asserting what directly leads to materialism; to the old dogma of fate or chance; to the eternity of matter, of the world, which is thus raised to the level of Deity in one of its leading attributes; finally, of being teachers of what tends directly to atheism.

It is generally admitted that many of the works of God, both of the material and spiritual parts of the creation, were produced at first not in a state of ultimate perfection, but in a state changing and continually tending towards that perfection: and that, not because God could not have made them perfect at the outset at once, but to accommodate them to the limited faculties of His intellectual creatures; that, as all things were created to shew forth the glory of His attributes, they might have ever new and increasing displays of His glory. And, if the angels, as the apostle tells us, desire to look into the mysteries of grace, certainly they, the spirits of the departed righteous, and perhaps other intellectual beings besides, must equally desire to look into the mysteries of the creative and preserving providence of the Deity. In this point of view the progressive changes upon this our earth afford a beautiful and instructive lesson, a series of appearing and evanishing pictures, on which are traced in every lineament the handywork of the Omnipotent. First, the world appears as a chaotic, dark, and probably a vaporous undefined mass. In this we see light breaking out, and the gradual arrangement of its components into the earth, consisting of dry land and sea, and the atmosphere surrounding it. Next, we perceive the dry land covered with a most luxuriant vegetation, as the distinguishing character of the earth at that time, that vegetation, however, being still only the lowest step in the scale of organised being. Following this, there is a farther improvement in the order and economy of the earth, by the creation of the sun and planetary system, and its assuming the proper orbit in which it at present moves. Then it becomes the abode of the lower grades of living and sentient beings, fishes, reptiles and birds, and is a world of which the abundance of these is the characteristic. To these succeed the higher orders of such beings, the mammalia, as occupying the chief place in it; and lastly, man is created, not merely living and sentient, but also intellectual and morally accountable. This is the presently existing state of the earth, moral agents being now the distinguishing class of being on its surface; and, in this state, it is presented to us under three successive aspects, as having on it man, created holy but soon sinful; man, sunk in ignorance of God, and degraded by the abominations of sin; man, now under the influence of grace, through which, by the universal spreading of the Gospel, the human race shall be intellectually raised, purified in their moral natures, and led to happiness. After this cometh the end, when the world shall be changed and its surface altered by fire; and it shall be in its moral constitution, not a world of intellectual beings merely, but also of beings possessed of purity and happiness, to which shall be joined the gift of immortality; for then death, and the till then changeful nature of our earth shall cease.

In all this succession of event and of being, each rising over the preceding in excellence and importance, we may discover increasing and richer revelations of the nature and character of God, as manifested through His works, in their progress to a higher standard of perfection; there is in them a farther and more abundant development, an unveiling of His glory; and a more extended and exalted field for the occupation of the observing, reasoning, and thinking faculties of intellectual beings of whatever class, whether angels or men.

Notes on Rajmehal Coal.[*]

At Rajmehal coal has been found by Captain Tanner in two situations; viz. at Sicrigully, on the banks of the Ganges, and at Hurrah, twenty-five miles distant. With regard to Sicrigully, this place has been recently visited by Lieut. Don, who reports to the Committee, that as far as he and Lieutenant Egerton, who accompanied him, could determine, no coal exists at the foot of the Mootee Jarna water-fall, where it was supposed to have been observed by Captain Tanner.[†]

2. At Hurrah, large quantities of coal have been extracted, but although we have every information relative to the

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[*] From the Proceedings of the Coal Committee.

[†] We are informed by Mr. C. Glass, that there is a coal mine at Sicrigully, but not at the foot of the water-fall, the spot visited by Lieut. Don, but near the village of Maharajpore, in the vicinity of the water-fall Mootee Jarna.—*Vide Proceedings of the Coal Committee.*

working, and expense of conveying this coal to the river, yet our knowledge regarding the natural circumstances under which it occurs is altogether defective. This coal is inferior, and without a more exact knowledge of the district than we are possessed of at present, it is impossible to come to any conclusion as to whether or not better beds of coal might be expected, and what measures would be most likely to be adopted with success in regard to them.* Major Forbes found by various experiments conducted at the Calcutta Mint, on five hundred maunds of the best Hurrah coal, that nearly double the quantity compared with the Burdwan coal, was required to produce the same quantity of steam, and that it is generally unfit for smithery purposes, affording an inadequate heat for melting, or even for hammering with facility, and on analysis, Mr. Prinsep found it yield upwards of a fourth part in ashes.

3. In a report on the Rajmehal canal, submitted to the Government in 1832, by Colonel McLeod and Major Forbes, it is stated, that Mr. Ward, the Commissioner of Bhaugulpore, was aware of the existence of coal in a bed of sandstone near the pass of Patchwary. This situation appears to be ten or fifteen miles to the north of Doobradgepore, and together with the Hurrah and Sicrigully indications, proves the extension of coal formations along the entire base of the Rajmehal hills.

4. In addition to the above-mentioned indications of coal, extensive beds have been found in a fourth locality, a few miles south of Patchwary. In April 1838, Mr. James Pontet found a bed of coal in the Rajmehal hills, on the banks of a nullah called the Burmany, sixteen miles distant from water-carriage during the rains, and about thirty miles west of

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* Mr. Glass states, that coal is found throughout a large tract of country, Barcoup. It is probably the same as that discovered by Captain Tanner; a portion of this coal is said by Mr. Glass to have been recently on fire.—*Proceedings of the Coal Committee.*

Moorshedabad, and nearly in the line of the canal proposed by Major Forbes. A specimen of this coal afforded the following results on analysis :—

Specific gravity, ... 1·370			
Volatile matter, ...	42	0	0
Carbon, ...	44	8	0
Earthy matter, ...	13	2	0
	100	0	0

A sample, consisting of a few maunds, furnished by Mr. Pontet sometime before to Mr. Scott, the commander of the *Jumna* steam vessel, also proved of favourable quality. Mr. Pontet having been desirous of procuring the means of extending his observation, these were provided, and on the 20th June, he despatched ten bags of coal to Calcutta, this also proved a favourable sample; but a subsequent dispatch of 400 maunds consisted of shale and inferior coal. In explanation of this last unfortunate circumstance, Mr. Pontet stated, that the necessary aid did not reach him till the rains set in, when the place being unhealthy, he was obliged to leave the raising and dispatch of the coal to inexperienced natives.

The following is an extract from Mr. Pontet's letter, in which he describes the operations in which he was engaged :— "After the first vein of coal, we came upon a hard black stone, and finding the operation of boring through it so very tedious, I took upon myself to select a spot for a shaft, and procured well-diggers and stone-cutters, who have been for the last two months at work, at present to all appearance, with satisfactory prospects, as one of the stone-cutters who opened shaft at Burdwan, says this mine bears some resemblance to it. I am induced to persevere a few feet more, in hopes of coming to an useful vein. The first twenty-three feet of soil is red and black earth mixed with kunkur, and under that, to a depth of forty-feet, are thirteen different strata, three of coal, and the rest various kinds of stone." Mr. Pontet transmitted to the Committee, specimens of all the different beds passed through, which are remarkably characteristic of the true coal measures; and of eleven different beds passed through in the last seventeen feet of the excavation, there were several beds of coal of good quality, but too thin for working, and in the shale we observed excellent specimens of *Vertabraria Indica,* Royle, one of the few abundant fossils of the Burdwan beds that happens to have received a name.

The excavation was formed on the N. W. side of the Burmany nullah, but Mr. Pontet states that he traced the coal a mile S. W. of the Burmany river, from which he concludes, that the Burdwan and Rajmehal beds are connected. Mr. Pontet subsequently found the indications of coal more extensive than he at first supposed, and that coal formations extend for ten miles round the village of Doobradgepore, the Burmany river passing through the centre of this coal district. In May 1841, a sample, consisting of ten bags of this coal was received. It presented the appearance of ordinary surface coal; forty lbs. used in one of the furnaces in the H. C's. Dispensary, burnt as well as inferior Burdwan coal, and left eight lbs. of ashes.

The following is the results of analysis of an average specimen of the sample in question:—

Specific Gravity, ...	1.4	
Volatile matter, ...		42
Carbon, ...		38
Ash, ...		20
		100

The report of Major Forbes on the quality of this sample corresponds nearly with these results.* The experiment was made by Mr. Gilbert at the Mint, and the result was, that

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* *Proc. Com. July* 1841, *para.* 4.

four maunds and twenty-four seers were only equal to three maunds and five seers of Burdwan coal.

A subsequent intimation having been received of the arrival of another sample of coal from Doobradgepore, dispatched by the same gentleman, consisting of 130 maunds, it was distributed by the Committee to the Mint, Cossipore Foundry, and the Laboratory of the Public Dispensary, for trial. Upon which Major Forbes reported from the Mint, that this sample was inferior to the last, and that it would not keep up steam. The report from Cossipore Foundry describes this sample to be of a dull brownish colour, with thin bright layers, and that it was evidently a crop or surface coal, and that twenty and half maunds were required to do the work of ten maunds of Burdwan coal. The appearance of this sample indeed shewed, that it should not have been selected, and that the persons by whom it was raised, were ignorant of the properties and appearance of coal. The Committee therefore considered it quite hopeless to expect any further information from this quarter, until a qualified officer, or practical miner, should be deputed to Doobradgepore, for the purpose of examining the district, and of deciding from amidst the numerous beds of coal, no doubt there to be found, the particular one, which, from its qualities and position would afford the best return in working. In the meantime, Mr. Pontet finding the steamers on the Ganges using wood, had a quantity of Doobradgepore coal delivered in January last at Bhaugulpore, for their use. To his disappointment, however, the Captains would not buy his coal; not that it was bad, but that they had nothing to do with the matter, further than to receive on board such fuel as the contractors for the supply of that article think proper to furnish. Unable therefore to obtain any remuneration for his expences, but at the same time anxious to have the quality of the coal tried, Mr. Pontet delivered it for nothing to the Captains of three of the steamers, who gladly accepted it on these terms, but only two of them granted receipts, and one only of three furnished Mr. Pontet with a statement of the result of the trial: but this report was so favourable, as to leave no doubt whatever as to the useful quality of the coal. *The report stated the sample of Doobradgepore coal, supplied by Mr. Pontet, to be equal in quality to Burdawan coal, and to be fifty per cent better than the wood, which they were then using.*

Coal, however, may now form too inconsiderable an item in public expenditure to render its supply a subject of much importance. In no other way can we account for its unnecessary transmission from the Damooda river (the lowest confluent of the Hoogly) up to Allahabad, a distance of 600 miles against the strong currents of the Ganges. If the labour and money thus fruitlessly thrown away year after year, were only to be directed for a short time to the Rajmehal and other coal districts on the upper parts of the Ganges, the result would not only be attended with much local improvement in several deserted tracts where coal is abundant, but would, after a time, lessen its expense very materially.

Extract from the Memoir of M. Peligot on the analysis of Sugar cane, and other Documents relative to the manufacture of Sugar. Communicated by G. J. Gordon, Esq.

Authors who have written on the cane, and the art of extracting its sugar, furnish information altogether erroneous regarding the real nature of this precious plant. In fact, no exact analysis of the cane, or of its produce had been made or published when, in 1822, Vauquelin attempted to fill the blank by procuring from Martinique some cane juice (or vesou) preserved by Appert's process. Unfortunately, this process, at that time new and no doubt ill-managed, did not succeed in effecting the purpose of that celebrated chemist. The vesou arrived in a state so altered, that it had lost its ordinary properties, and Vauquelin was obliged to confine himself to making known the singular substance into which the sugar contained in the liquid had been transformed, in consequence of viscous fermentation.

M. Gradis, a merchant of Boardeaux, proposed about a year ago, to procure for me some cane juice and canes, that by the examination of those bodies, light might be thrown on some points in the manufacture of colonial sugar. I eagerly accepted this offer, and I lately received these substances preserved by the very simple processes I had prescribed. These were—the desiccation of the cane at a low temperature, and the employment of Appert's process, now every where well understood, for the preservation of the cane juice.

The vesou which I have examined, was obtained in the ordinary way by expression from the pure cane, was immediately introduced into common bottles, which were gradually raised to the temperature of 212° F. and then corked and cased in pitch. The operation succeeded perfectly. The vesou in the eight bottles that have been sent me, presents, according to the Planters who have examined it, all the characters of the ordinary cane juice. It is a cloudy liquid of middling fluidity, holding in suspense that greyish globular matter that is found in the expressed juices of almost all vegetables. It is known, that when sugar is also present, this matter acts as ferment, and transforms it into that viscous substance described by Vauquelin. By only raising the temperature to 212° Fahr., that to which this vesou was submitted, the organisation of this substance is destroyed, and it actually loses its fermenting property.

The density of this cane juice is 108.8, corresponding to twelve or thirteen degrees of Beaume's acrometer.

It yields a balsamic odour peculiar to the cane, and which is so marked in raw colonial sugar. By filtration through unsized paper it is obtained limpid, and has then a very clear citrine tint, but whether opaque or transparent, it undergoes no alteration by long exposure to air.

Evaporated at a gentle heat after having been filtered, it becomes a syrup, which placed in dry air, furnishes after some days a hard, crumbling, colourless mass, *and this mass consists of crystalized sugar, almost pure.*

The analysis of this liquid is therefore remarkably simple, for it consists merely in evaporating a given weight in a capsule, which is again weighed when the substance has become solid red, and quite dry.

We arrive at the same end, still more surely by evaporating the liquid at the ordinary temperature under the receiver of an air-pump only, and it is a fact deserving attention, that the thickest syrup that can be thus obtained, does not crystalise even after the lapse of many days. The addition of a small quantity of alcohol appears necessary to determine the crystalization, which then becomes complete in a few hours. This effect is probably due to the coagulation of the vegetable albumen which exists in very minute quantity, as we shall presently see.

I have ascertained by the common processes, the other substances that exist along with sugar in the cane juice. By evaporating a given weight of vesou, and incinerating the residue, we get 1.3 per cent. of white ashes.

These ashes consist of sulphate of potass, lime, alkaline, chlorate, and other salts, found in the sap of almost all vegetables.

The sub-acetate of lead which precipitates all organised substances except sugar, and which produces especially so considerable a precipitate from beetroot, causes only a slight quantity of greenish deposit from cane juice. Admitting vegetable albumen to be the organic substance united to oxide of lead that forms this precipitate, it hardly amounts to a two-thousandth part of the weight of the cane juice.

Accordingly, the vesou I have analyzed is composed of

Sugar, ...	20
Mineral salts and albumen, ...	1.5
Water, ...	78.5
	100.

The juice of the cane may therefore be considered as an almost pure solution of sugar. This appears to be an important result, for without admitting, as was formerly alleged, the pre-existence of molasses or uncrystalizable sugar in the cane juice, it might still be supposed to contain some substances, the presence of which hinder the crystalization of some portion of the saccharine matter.

It is well known, that in the manufacture of sugar from the cane, there is always a considerable quantity of molasses formed, amounting sometimes to one-third of the sugar obtained. It seems that the production of molasses may be much diminished, or may entirely cease, by recourse to more perfect heating apparatus.

One of the great dangers in the manufacture of cane sugar appears to consist in the rapid fermentation that the vesou undergoes if exposed for some time to the air. This alteration which destroys so great a quantity of sugar, may probably be escaped by speedily raising the temperature of the juice as soon as expressed to 212 Fahr.

In defecating the juice by lime in the ordinary way, and evaporating it at a rapid-fire, I have also obtained the whole of the saccharine matter in a solid state, without a trace of molasses.

The leaves that I received with the vesou had been cut in bits and dried in an oven at 140° Fahr. M. Faraud, apothecary at Martinique, who undertook this double preparation, obtained 7 kil. of dry cane from 24 of the fresh.

The desiccation, however, was not complete, for on submitting them to the temperature of 212° Fahr. in a stove, they lost 9 or 10 per cent. more in weight.

Accordingly, the fresh sugar cane contains solid matters, ... 28
Water, ... 72
100*

In treating the dried cane either by hot or cold water, the sugar is separated from the insoluble or ligneous matter. We thus find that the dried cane contains of soluble matter, ... 64.7
Ligneous matter, ... 36.3
100

From the analysis of the vesou, it appears that these 64.7 parts of soluble matter consist almost solely of crystalizable sugar.

From these numbers besides, we may easily deduce the relative proportions of the three principal constituents of the fresh cane, these are water, 72.1
Sugar, ... 18.
Wood, ... 9.9
100

The sugar cane then contains in theory 90 per cent. of juice, but so difficult is it to crush, and so spongy is its texture, that at Martinique it seldom yields more than 50 per cent. on an average.

Probably with better machines and by crushing the bagasse (or cane trash) a much larger produce might be obtained.

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* If the 7 kil. to which the 24 kils of fresh cane were reduced by the first drying lost 10 per cent. by the second drying, there remained only 26¼ per cent. of the original weight, not 28.

Report of the Committee of the Academy, by M. THENARD, *on the Memoir of* M. PELIGOT, *of which the foregoing is an extract.*

Researches having for their object the exact determination of the relative quantities of the different matters obtained immediately from sugar cane, would at any time command the special attention of the public, but at the present day, they possess a new degree of interest from existing circumstances.

M. Peligot therefore deserves praise for having undertaken such researches, and the more so, that he has succeeded in correcting very mischievous errors in an art so important as that of extracting the sugar of the cane.

The authors who have engaged in the analysis of vesou, or cane juice, had regarded it as water, holding in solution sugar, gum, albumen, mucilage, a sort of soapy matter, acids, and different salts, as in short, a very complicated liquid; to which circumstance they attributed the difficulty of extracting the sugar.

M. Peligot shews, on the contrary, that filtered vesou is formed simply of four parts of water and one of crystalizable sugar; that it is only sugared water, or at least, that the other organised or saline substances found in it do not amount to 1.7 part per 100 of its weight.

Examining next how much juice is contained in the cane, he finds with M. Avequin, that it holds 90 per cent. Therefore, as the sugar forms a fifth of the vesou, the fresh cane must contain 18 per cent. of sugar, a much larger quantity than that which has been always allowed to it.

How happens it, notwithstanding, that the manufacturers obtain from the cane only six to eight parts of sugar, and three to two of molasses from 100 parts of cane? Or even according to M. Jabrun, Delegate from Guadaloupe, that the sugar produced amounts to only 4 per cent., and the molasses to 1.7? It is because the rolling mill extracts only $\frac{5}{9}$ of the juice according to the researches of M. Peligot and M. Avequin, and only $\frac{2}{5}$ according to M. de Jabrun.

At all events it is now well established, that a great quantity of sugar remains in the milled cane, and is burned with the bagasse.

Would it not be possible to extract this quantity by bringing the ground cane into contact with water nearly boiling ?

On the other hand it is certain, and all chemists are of one accord on this point, that the present processes of evaporation and boiling leave much room for improvement, and that they give rise to the formation of a great deal of molasses.

M. Peligot, it is true, has operated only on a single quality of vesou and on one species of cane, for which he was indebted to M. Gradin. Perhaps if he had tried other specimens of vesou, and other species of cane, he might have arrived at results somewhat different.

However that may be, the cane contains more sugar than was believed.

A great quantity of sugar remains in the bagasse.

Cane juice is merely sugared water.

The manufacture from the cane juice is at present conducted by very imperfect processes.

There is therefore every reason to hope, that important improvements may be introduced into the art of extracting sugar from the cane, and that by these causes, a much larger quantity of sugar will be obtained than by the processes hitherto followed."

Extract of a Letter of M. Guibourt.

" I will not here call to mind the important labours of Dutrône and others besides, but I think it right it should be known, that an apothecary, a chemist as able as modest, whom fortune has carried to a distance from his country, has availed himself of his residence at New Orleans to make a complete analysis of sugar-cane, and the results he has obtained are well worthy of citation. M. Avequin, an extract of whose memoir is to be found in the Journal de Chemie Medicale of 1836, pp. 26 and 132, has found like M. Peligot, that the cane though it yields to the best mills only about half its weight of cane juice or vesou, contains however 90 to 91 per cent., " so that," he writes, "of a Planter who makes conveniently 300 hogsheads of sugar, could make 544 if he were able to extract all that the cane contains." "In practice," he adds, "we shall never attain that limit but by some improvements in the cylindrical rollers. It will be possible to obtain 75 parts of juice from 100 of cane, which will be upwards of $\frac{4}{5}$ths of its whole contents."

M. Avequin, however, does not carry so high as M. Peligot his estimate of the quantity of sugar that may be obtained from the cane, but that is evidently owing to the climate of Louisiana, which is ill adapted to the culture of sugar-cane, for there it has degenerated; and it is known that the plant contains less sugar the further it grows from the Tropics, in so much, that it will probably be found an unprofitable attempt to cultivate it in Algeria. Further, the results of M. Peligot are found verified to a certain extent by those of Dutrône, who points out a variation in the density of cane juice of from the 5th to the 14th degree of Beaumé, and who admits that 25lbs. and 11 ounces of sugar may be obtained from a quintal of vesou of the latter degree of density, which would give no less than 23 parts of sugar to 100 of cane. But such a produce is quite a maximum that will never be attained in practice, no more probably than the result little short of that obtained by M. Peligot.

M. Robiquet confirms the statement of M. Guibourt.

M. Thenard adds, that M. Peligot was aware of the labors of M. Avequin, and had not failed to mention them in his memoir."

Extract of a Letter from M. Peligot.

"A letter from M. Guibourt read at the last meeting, claims in favor of M. Avequin, Pharmacie at New Orleans, the priority of some of the results that I have pointed out in my analysis of the sugar cane of Martinique. If M. Guibourt had read my memoir, he would have seen that I have cited from the text that part of the work of M. Avequin to which he calls the attention of the Academy, relative to the ninety per cent. of vesou contained in the cane. There are, it is true, other parts of the memoir of M. Avequin on which I have less relied, because the experiments on which they rest, appeared to me inaccurate.

My analysis of the vesou sent from Martinique demonstrates, that the whole of the sugar contained in the cane is crystalizable. That I consider the important result of my labors, for all the chemists who have gone before me have admitted the existence of a large proportion of liquid sugar or molasses in the cane, and have thus so far justified the notorious imperfection of the colonial manufacture. M. Avequin only confirms former ideas by admitting that the sugar cane of Louisiana contains for seventeen parts of sugar, five of molasses and extractive matter.

I thought it sufficient to oppose by facts the opinions of Casaux and Dutrône on the pre-existence of molasses in the cane, and to shew, that this substance is formed by the alteration of the juice in the colonial process."

Result of the Researches of M. Plagne, *on the composition of Vesou.*

In a recent work M. Peligot has been led to consider the juice of the Aruncdo sacharifera as sugared matter, of which the saccharine matter wholly crystalizable, amounts to 18 or 20 per cent. That figure, as has been remarked by M. Robiquet and M. Guibourt is precisely that which had been found some years ago by a pharmacie, M. Avequin, in his researches into the composition of the sugar-cane.

I may be allowed in my turn to remark, that one of my former fellow-labourers at the Ecole Polytechnique, M. Plagne, arrived at the same result in 1826. His experiments detailed in five successive reports addressed to the Minister of Marine in 1827, establish that the juice of the cane contains, as well in Martinique as in the Coast of Coromandel, more than 20 per cent. of crystalizable sugar, that can be obtained wholly of the juice by rapidly evaporating at a temperature not exceeding 212° Fahr.; that the quantity of molasses under the treatment is null or insignificant; that rapid evaporation is the more desirable, because cane juice contains a substance which otherwise converts the whole of the sugar into various matter.

I will revert presently to the nature of this ferment, but I must first shew the result of M. Plagne's analysis of the vesou. He acted on 4,000 grammes.

Water, ...	3133 grammes.
Crystalized sugar, ...	832
Dry residue not crystalizable, ..	30
Cérine, ...	.30
Gum wax, ...	1.06
Peculiar organised matter, ..	1.61
Dry albumen, ...	.30

The sum of these quantities .... 3998.27 differs only by seven decigrammes from the 4,000 grammes submitted to experiment.

The peculiar organic matter observed by M. Plagne, and which does not reach a 2000dth part, is that which connects sugar into viscous matter when evaporation is not immediately proceeded with, or carried on too slowly. Its properties, as observed by M. Plagne, are these; it is white, becoming brownish by contact with the air, soft, slightly attractive of moisture, and drying with difficulty. It is insoluble in alcohol or ether, soluble in water, not azoted, burning without smelling with an odour analogous to that of the extract of chicory. The salts of the protoxyde of mercury and those of lead precipitate it from its solution in water. The perchlorate of mercury produces on it no effect. Alcohol and ether separate it, with its primitive properties, from the water that dissolves it. Arsenical charcoal seizes it, but for this effect it is necessary to use a large quantity, and to add a portion to the juice at the instant of its flowing from the cane, in order to prevent the viscous fermentation.

The viscous matter into which the sugar is converted by the substance just described does not yield carbonate of ammonia on distillation; whence it may be inferred, that it does not contain azote. Water dissolves it, and from that solution it is precipitated by alcohol. It has therefore the properties of gum; yet treated with nitric acid, it yields only oxalic acid. May not this substance be analogous to that obtained by M. Pelouze from certain ferment, and which he considers I believe as an anhydrated sugar.

As to the species of ferment remarked in the cane juice, may it not be the same as that obtained from the tubercules of the Helianthus by M. Braconnot ?"

Extract from Ure's Dictionary of Arts—Article SUGAR.

Out of lbs. 120 millions of raw sugar which used to be annually shipped by the St. Domingo planters, only 96 millions pounds were landed in France, according to the authority of Dutrône, constituting a loss by damage in the ships of 20 per cent.

The average transport waste at present in the sugars of the British colonies cannot be estimated at less than 12 per cent., or altogether 27,000 tons! What a tremendous sacrifice of property!

Within these few years, a very considerable quantity of sugar has been imported into Great Britain in the state of concentrated cane-juice, containing nearly half its weight of granular sugar, along with more or less molasses, according to the care taken in the boiling operations. I was at first apprehensive that the syrup might undergo some change on the voyage; but among more than a hundred samples which I have analized at the custom-house, I have not perceived any traces of fermentation, since sugar softens in its grain at each successive solution. Whatever portion of the crop may be destined for the refiner should upon no account be granulated in the colonies; but should be transported in the state of a rich cane-syrup to Europe, transferred at once into the blowing-up cistern, subjected there to the reaction of bone black, and passed through bag filters, or through layers of the coarsely ground black, previously to its final concentration in the examine pan. Were this means generally adopted, I am convinced that thirty per cent. would be taken from the amount of molasses. The saccharine matter now lost by drainage from the hogsheads on the ships, amounting to from ten to fifteen feet, would also be saved. The produce of the cane would on this plan require less labor in the colonies, and might be exported five or six weeks earlier than at present, because the period of drainage in the curing house would be spared.

From the foregoing Extracts, one most important practical lesson may be drawn.

It is quite clear that the substance, the presence of which gives rise to fermentation in the cane-juice loses this deleterious property by simple exposure to the boiling temperature in 212° F. But further, Peligot found that not only the cane-juice that had been raised to that temperature shewed no disposition to ferment, but that the cane itself, after having been exposed to the same heat in a stove, yielded its sugar to either hot or cold water without a trace of molasses. The principle is one of easy application, requiring only that a boiler be placed immediately under the rolling mill, into which cane-juice and cane-trash may be allowed to fall in the first instance, leaving a spout at one extremity from which the cane-juice may be drawn and thence carried to the boilers, while the cane-trash is brought to a state in which it will yield much of its remaining saccharine matter to fresh pressure, without being liable to fermentation.

Extract of a Letter from Dr. LUND, *on the Brazilian Ant.*

In sending you the promised Notes of the habits of those species of ants which I have had an opportunity of observing in Brazils, I take the liberty to add, that if you wish to make them public, you may be pleased to observe, that they were not intended to see the light, any more than other observations I may have made during my sojourn in this country, at least until my own return to Europe enabled me to render them into a more perfect form.

It is a fact which has not escaped the notice of the travellers who have visited the tropical parts of South America, that the families of ants which there present themselves are much more numerous, as well as regards species as individuals, than with us. Notwithstanding Brazils being well-known, its extraordinary entomological riches have convinced me, that the ants there form a much greater proportion to other insects than with us. Every where you turn your eyes in that rich country, you meet with these animals. On the ground, in the grass, on the leaves, on the stems of trees, and underneath their bark, in almost all decayed plants and animal matters; they penetrate into houses, pave their way into the villages; even the capital of South America is visited by innumerable swarms of these destroying animals.

It is chiefly in the great table land which occupies a considerable part of the *midland* country of Brazils, and which after the language of the country bears the name of Campos Geraes, where this family has its head-quarters. This otherwise flat country assumes sometimes a hilly appearance, which is chiefly owing to the indefatigable activity of these animals.* Numerous hillocks which I cannot compare better than to those hills found now and then on our own fields, and which are known by the name of ant hills, extending every where before the traveller's view, and interrupt his *walk*. But extraordinary as the multiplicity of these animals is, it is trifling compared with the means nature employs in keeping them within proper limits. Here is the native country of the typical species of Myothera, or Birds whose exclusive maintenance these animals afford. Here are found the gigantic species of mammalia *Myrmiephaga* or Anteaters, and the *Dasypus,* which in every meal devours millions of these small animals.

It is easily perceived, that these animals on account of their extraordinary multiplicity, in connexion with their peculiar activity, are destined to play a conspicuous part in nature's great œconomy. No other family of insects can in this respect be put in comparison with them. Nay, they were seen to play in addition to their own, a part, which has been assigned in Europe to several other insect families.

As for instance the Carabici which perform no unimportant service in destroying a number of insects; all these families are limited in tropical America to very few species, and the ants supply their place.†

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* All the hillocks of this kind, which I have had an opportunity in examining, were inhabited by ants and not by *termitis;* hence no doubt, most of the *fallacious* information of travellers, on which the general *belief* is founded, that they are the production of these animals.

† The inhabitants of Rio Janeiro have assured me that they, far from regreting the *presence* of ants in their houses, sometimes even introduce them there, in order to secure the dwelling from a much more dreadful enemy the *termites.* I must here on this occasion mention an opinion which is generally *believed* in Brazils, that there exists a peculiar antipathy between these two species of

Such is also the case with another insect family, (Necrophaga,) which in Europe performs a more conspicuous part. In the part of South America I now treat of, we do not find these animals; ants being only met with in decayed animal matters, and the activity with which these small animals execute the extremely important office alloted to them in tropical countries is wonderful. Often have I found on omitting ordinary precautions, the fruits of my labours lost, when for a moment I have put away the box in which I preserved fresh killed insects; it has even sometimes happened that before I could penetrate the brush wood to take up a bird I had shot, that these gluttonous little animals had already so attacked it, that its skin was rendered useless for stuffing.

But these animals render important services in destroying noxious insects and animal matters in tropical climates; yet the destruction they cause in directing their attack against the productions of the vegetable kingdom is a great drawback from their good services. They are the most dangerous enemies of all kinds of plants, in such degree, that one hardly hears the husbandman complain of any other evil. I may here pass by the mischief they commit in attacking the roots, in quartering themselves in the stem, in destroying fruits, &c. in order

animals. As I am deficient in observations regarding this case, I will not attempt to say how far this is correct or not; but I take the liberty of quoting a fact, which at first appeared to render it very probably correct. One day while busy in pulling down a termit habitation to examine the inside, I perceived to my great astonishment, that a portion of the dwelling was taken possession of by a kind of ant (*Myrmica paleata*, Mihi,) which as soon as they discovered the attack made on their dwelling, rushed out furiously, dispersed themselves amongst other habitations also over the ruined heaps of that part of their own dwelling; a good many caterpillars happened to lie exposed on top of the ruins of their habitation, and by degrees as the ants met them, they attacked them with great fury, pierced them several times with their sting; without conveying them when wounded to their nest. This appeared to me in the commencement to the opinion above adverted to, of the antipathy between these animals; but I soon discovered a circumstance which afforded what appears to me to be a better explanation of this circumstance. I perceived a troop of a different species (*M. erythrothorax*, M.) which emerging from the same hill, cautiously approaching, and in the midst of blood-shed, deliberately conveyed the killed and wounded *termites* to their common habitation without the least excitement. These last ants were merely the reserve troops and slaves to the first; they were obliged to provide for the victualling of the republic, while those, soldiers by profession, had only its defence in view, and for that reason attacked the *termites* as they would have attacked any real or feigned enemy they might met with on the road.

to notice a phenomenon which in Europe is only known from the reports of travellers. I mean the extraordinary destruction they commit on trees in stripping them of their leaves in a very short time. I have always looked upon the traveller's tale on this head as exaggerated, until an opportunity of witnessing the circumstance occurred to myself. I refer to a species of ant, which has been known a long time under the name of *Atta Cephalotes*. We daily perceive these ants in the sands of the beach, dragging leaves home to their nest; but as they generally obtain these materials from the thick coppice, one cannot trace their destructiveness home to them in its whole extent. A lucky circumstance, however, having afforded me an opportunity of observing their pillage at leisure, I think you will perhaps peruse the account of it with some degree of interest.

One day while passing a solitary tree, I was astonished at hearing in perfectly calm weather, a rustling as of leaves, which fell down in numbers. On looking round, I soon perceived that these leaves came from the tree I had passed. It was of the laurel family, about twelve feet in height, with stiff leathery leaves, which on falling to the ground caused a considerable rustle; but what excited my astonishment was, that the falling leaves had a perfectly green appearance, and that the tree seemed to be perfectly *fresh* and sound. I was therefore at a loss to account for the leaves falling, when to my astonishment, I saw an ant sitting on each leaf stem (petiole) working away with all its might in biting it off, in which it always in a short time succeeded, so that the leaf fell to the ground. On looking further into this matter, I found that the root of the tree was completely covered with ants, which were all warmly engaged in reducing the leaves into transportable pieces, and which were immediately conveyed to the nest. A line of these animals carrying away the pieces of leaves, extended itself already as far as the eye could reach from the foot of the tree across the country. Such a *cavalcade* presents a curious spectacle; the pieces of leaves being much larger than the ants, which are consequently almost entirely hid under their load, so that the whole is like an expedition of wandering leaves; and in less than an hour was this great work completed in my presence.

Another extraordinary feature in the habits of the tropical ants met with in South America, and which in Europe is likewise only known from the reports of travellers, consists in the wanderings certain species undertake, from time to time, in incredible swarms. The main circumstances of this phenomenon being as yet unknown, I hope that the occurrences I am able to communicate to you, will not prove unacceptable. To a considerable extent the ground is covered with ants, whose motions seem to proceed in all directions, and presenting to the eye nothing but confusion, On observing attentively, however, we find that the whole body advances, although rather slowly, in a certain direction ; all that they meet with in the shape of insects, they drag along with them. How long the expedition lasts I cannot say; the longest time I had an opportunity of observing it being only five days, on this occasion the march was continued day and night. Should they in their wanderings fall in with a house, they penetrate it by thousands, and the inhabitants must leave it for the time, hence their nocturnal invasions are often as you may suppose very troublesome. They do no further harm, but on the contrary, make up for the inconvenience they occasion, by clearing the house of all sorts of vermin. These immense swarms are continually on their march accompanied by a flock of birds, which destroy a great number of them, and which by their shrill cry, announce the arrival of the insects while they are yet at a distance. As regards the season at which these expeditions happen, I must observe, that all those I find marked in my Journal, take place in the months of June, July, and August. Should this eventually prove to be the only season of their migrations, the circumstance might perhaps throw some light on the season and purpose of this expedition. This season nearly corresponds with our winter, and is, like that, characterized by a considerable diminution in the number of insects. Now, as these afford the principal food of the ant, it is probable, that very numerous societies of ants, not finding in the neighbourhood of their dwelling a sufficient stock of nourishment for the daily subsistence of the republic, are on that account *forced* to emigrate. From this it is seen, why these wanderings do not take place in Europe where the ants hibernate, and are consequently exempted from roving about to seek for their food.

The extraordinary instinct of these animals, which recent observations have brought to light, is no doubt similar to that which Huber has observed to belong to different species of European ants, and which consists in one species carrying on formal warfare with the other, and having defeated their armies, penetrating into their dwellings and carrying away in triumph their cocoons and caterpillars. The ants hatched from these, must now serve during their conquerors' lives as slaves, must provide for the victualling of the republic, for the preservation of the dwelling, and the hatching of the brood. From military service only are they exempted. I have found the like instinct in the ants of the New World, as I have already mentioned. A species (*Myrmica paleata,*) whose hill contained individuals of the *neutral sex* of another species, (*M. erythrothorax,*) these were obliged to provide for the victualling of the republic. I have observed this similarity, even in another species, which forms a new genus, (*Ancylognathus lugubris, M.*) while one day encountering its armies coming home from a pillaging excursion. They marched in close ranks, were loaded with cocoons and caterpillars of ants, and no doubt had to do with a valiant enemy, who unwilling to surrender their liberty, sold their lives as dearly as possible; because almost all the specimens I saw had their legs more or less mangled. I believe such traits of character to be pretty common amongst the numerous species of ants in Brazils, as nothing is more common there than such close drawn ranks of ants, marching in great haste, and without carrying any thing which would account for their object ; while the victualling of the habitation is executed in a quite different manner.

There has already been observed amongst some of the species of European ants, particularly in individuals of the *neutral sex,* a peculiar race, which are distinguished from the others by a more considerable size of the body, but especially of the head. These varieties are much more conspicuous amongst certain foreign ants, and which on that account are called *Atta cephalotes.* But what has little been suspected is, that such varieties or distinguished individuals perform distinct functions in society from the common working ants. I have had an opportunity of verifying this in a species of the genus *Myrmica,* which I intend to describe more fully in *Guerin's Entomological*

Magazine. Of these ants, I one day discovered a line, which led across the yard in my dwelling; it emerged from two holes in the ground, which were probably the outlet of subterraneous channels leading to a neighbouring plain, and all ants from these holes, were loaded with spoils, consisting of different kinds of insects. But coming in the contrary direction, in the same line, were seen an equal number of ants which resorted to the two before mentioned holes. These last carried nothing. The principal part of the army consisted of individuals, varying little in size, but here and there was to be seen a few much larger, distinguished, as before mentioned, by the disproportioned size of the head. These scarcely ever followed the movements of the army, but marched at one time slowly in the contrary direction, at another across the line; or, when they followed the same direction as the main body, did not keep pace with it, but went quicker or slower, according to circumstances. I stood about a couple of hours, and observed these animals manœuvre, and all that time I saw posted round the two holes I have mentioned, four of these great individuals, who stood perpendicular on the four hind legs, head raised, and their very large hooked jaws much extended. Round the other hole, stood two of these, others in similar position. After the lapse of two hours, when about to avail myself of a closer inspection of what was going on, I commenced to trample down the straggling individuals which swarming along the side of the main army intercepted my approach. But I did not remain long in possession of the usurped territory, for no sooner did the nearest marauders observe their comrades' bodies than great uneasiness manifested itself amongst them, and some of them retreated in great haste to the nearest hole. I immediately observed the four sentinels which stood round and guarded the hole for two hours without interruption, hurry eagerly to the place where their comrades were murdered; a swarm of the common working ants followed their example, and in a moment the whole place where I had trampled the ants to death, was covered with their comrades, actively occupied in removing their bodies which they transported to the hole. Amongst this crowd, I counted ten of the large race; these took no care of the dead, but ran about with extraordinary quickness and expanded jaws. The place was cleared in less than a quarter of an hour; during this time the march of the troops continued as before. I also observed, that while the transportation of the dead lasted, none of the ants which emerged from the holes were loaded with spoils as before, and it was only after tranquillity again had been perfectly restored, that the transportation of their loads was resumed. But what particularly demands attention, as deciding the part those large individuals play in the society, is, that while the hole which was nearest the place of carnage having only before been surrounded by four of these animals, was after this affair guarded by nine, who all stood in the same singular position.

I confess that this is the only species of ant in which I observed this phenomenon in a manner so conspicuous; but I observe in the new edition of *Cuvier's Regne Animal,* that my friend M. Lacordaire, to whom I had the pleasure of communicating these observations during our meeting in Brazils, has had the opportunity of seeing the same peculiarity in another species, which approaches to *Atta cephalotes.*

With the history of our ants is connected that of two other families of insects, with which ants maintain an intimate intercourse. This connection between different species of insects has astonished observers by that analogy which it presents, with those associations that takes place between man and certain mammalia; thus the leaflies and gall insecta are represented by happy metaphor, as the cows and the goats of the ants—Ant-cows, and ant-goats.

Having been familiar in Europe with the association of leaflies and ants, which there often excited my astonishment, I was surprised at first at the absence of leaflies in Brazils, notwithstanding the extreme multiplicity of ants, and I was on the point of believing that the ants of Brazils were deprived of a source of enjoyment, of which our ants in Europe know how to make such excellent use; but I was soon convinced that I was very wrong in supposing that the ants of the New World were less fortunate in this respect than their brethren in Europe. For as after the discovery of the New World, we there met with civilised nations, with whom certain species of animals occupied the place of our domesticated animals, so, in like manner, have I found in the small nations, of which we are treating, certain species of domesticated animals, which perform the same part in their œconomy.

Those animals to which I refer belong all to the division of which Linné formed his great family of *Cicada,* and which agrees with Latreilles' family, *Cicadelles.* These animals, especially the species of genus *Cercopis* and *Membracis,* assume in their cocoon and caterpillar state, a mode of life which has many points in common with the leaflies. They are found in numerous societies, clustered together below the leaves, and round the young sprouts of plants, on which part they cause the same monstrous protuberances which are produced by the sting of the leaflies. The sap which exudes from this, assumes a sweetish flavour, occasioned by some change effected in the bark by means of the clear liquor, which exudes from the hind part of the leaflies.

It is on account of this moisture, of which the ants are very greedy, that they frequent the society of these animals, which they treat as our ants treat the leaflies ; caressing them on the side of the body with their antennæ or hand, which caresses expel a liquor, which is immediately swallowed by the ant. I must, however, observe, that while in Europe most species of ants hold communication with the leaflies, I have only found in Brazils one species, which seeks the society of the *Cicadelles* (*Dolichoderus attelabœdes, M.*) This species seems to obtain its whole nourishment from these animals ; at least I have never seen it seek any other, and one sees it bestow extreme care on these animals.

I have no doubt, that the list of the domestic animals of the ants will be considerably increased, when we understand better the domestic œconomy of these animals in the great regions of the earth yet unknown to us. I have even reason to believe, that the ants do not limit their choice in this respect to the insect class alone. I have found a species of ant which on account of its blindness I call *Myrmica typhlops,* which convey living *Onisci* to their nest, and the sight of such a burden is highly amusing. The *Oniscus* hangs under the belly of the ant, to which it clings with its claws, but its body being much broader than the ant's, this last is obliged to stride over it when it runs, which gives its walk a very curious appearance.

But to what qualifications these animals owe the honor of being enrolled amongst the ant's domesticated animals, is unknown to me.

M. E. De Beaumont's Views of the relative Age of the European Mountains, an abstract by PROFESSOR SCHOW.* *Communicated by* W. M. WESTERMANN, ESQ.

A few years ago, geology consisted only of a collection of curious hypotheses; it now however occupies a place amongst other sciences, since it possesses a great mass of precise observations. Some of the general results derived from these, deserve our attention in the highest degree, because they afford us instructions as to the original state of our globe, and the astonishing revolutions which from time to time it has undergone.

It is now almost a general opinion, that the mountain masses have been elevated from the bosom of the earth, and that there accordingly was a time, during which the surface of the earth did not present any considerable unevenness.

The adoption of this view has removed considerable difficulties connected with many of the most striking phenomena of fossil shells, which are found on many of the highest mountains, and which can now be satisfactorily accounted for, without supposing that the sea has stood higher than these mountain masses; because we need only to suppose, that the mountains in being elevated, have also lifted the earlier masses which were deposited by the sea, and by this means brought them to a height, which often exceeds 12,000 feet.

This supposition, that the mountains have been elevated from the bosom of the earth, suggests a number of interesting questions. Thus for instance, we may ask, if the great mountain masses have all been upheaved at one time; or, if this has not been the case, in what order then did their upheavement take place? This is the subject which M. Elie

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* From Poggendorff's Annalen 18ter. og. 25ter B. et. 1, fornemmeligen efter Aragos Fremstilling's Annuaire, 1830.

de Beaumont has treated, and the problem which he has in a satisfactory manner solved.

Amongst the very different masses of which the earth's surface is composed, there is found a class, which forms what is called *flöts bjerge;* i. e, mountain masses of sedimentary stratified rocks.

The real *flöts bjerge,* consists entirely or partly of sand, mud, and finely divided masses, which have been carried away by the water like the mud in our rivers, or the sand at the sea coast. This more or less fine sand, formed after it had been cemented by lime as a clayish mortar, that kind of mountain which is called sandstone.

Certain sorts of limestone belong also to *flöts bjerge;* as those remains of shells which are found in them, in an another and still clearer manner proves that they were formed in waters. *Flöts bjergene* consist always of considerable layers, which rest on each other. To these formations belong principally the following, which are here ranked according to their ages :—

1. Coal formation.
2. Jura limestone.
3. Green sand and chalk.
4. Tertiary formation.
5. The early tertiary uplifted land.
6. Quaternary formation, consisting of the newer upwashed land.*

Although all these varieties of mountain masses were deposited by water, and are found collected and grouped above each other, yet the passage from one to another is not

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* The coal formation contains the great beds of coal which lie in sandstone, distinguished by the many impressions of ferns found in it.

The Jura limestone is a whitish limestone, sometimes compact, close, and even, as the stone serves for Lithography, and sometimes consists of small round grains (*rognsteen* i. e. pea-stone, or oolite). The name is derived from the Jura chain, which mostly consist of this mass.

The green sand and chalk formation consists of sandstone layers, always imperceptible. On the contrary, we often observe a sudden alteration in the nature and quality of the masses, as well as in the strata themselves, and also in the remains of organic beings imbedded in them.

Thus for instance it is clear, that between the formation of Jura limestone, and that of the green sand and chalk on which it rests, an alteration in the state of things on the earth's surface took place. The same can be said of that epoch, which divides the chalk from the tertiary formation; it is likewise clear, that between the tertiary formation and the formation of the early tertiary uplifted land, a decided alteration must have taken place in the nature of the remains, by which these mountain masses are distinguished.

These great changes in the nature of those bodies deposited by the waters, are regarded by geologists as the effects of those occurrences which they call the revolutions of the earth, although it is difficult to say, in what these revolutions have consisted; yet it is nevertheless certain that they have taken place.

The order in which the formations succeed each other, has been discovered by tracing uninterrupted, each mountain mass to its connection with adjoining plains, in which one can observe with certainty, on great horizontal extensions, that a certain formation lies on this, or that layer. Mountain slopes, steep and high river banks, high coasts, artesian and other wells, as also river channels, have in this respect been of great service.

with which a great quantity of small green grains occur, and is covered with chalk strata. The coasts of France and England on the Channel, present many cliffs which clearly shew this formation. Tertiary formation consists of many layers of clay, lime, marl, gypsum and sandstone.

The early tertiary land *(diluvium)* and the Quaternary upwashed land, (alluvium) derive their names from their similarity to those augmentations of sand, mud, &c., which are now daily formed by the sea and the rivers.

It is already observed, that *flöts bjerge* repose in layers. In plains, these layers are found as we should expect in an almost horizontal position. But if we approach the mountains, this position is generally altered; on the sides of the mountains the layers are very slanting, and even sometimes they stand perpendicular.

Are we now to think it likely, that these oblique layers of *flöts bjerge,* which we see on the sides of the mountains, were deposited in this oblique position. Is it not far more natural to suppose that they also, as well as the contemporary layers of the same masses in the plains, have originally formed horizontal layers, when those mountains which they rest against were lifted up above the former surface of the earth ?

Exact geological observations have shewn, that those limestone layers, composing the summit of Buet in Savoy, and Montperdu in the Pyrenees, are identical at an elevation of from 9 to 12,000 feet, with the chalk strata, on the coast of the English Channel. If the fluid which deposited this chalk, had stood 9 to 12,000 feet high, it would have covered the whole of France, and such-like masses should be found on all heights under 9,000 feet. But it has been observed in the North of France, where these masses present themselves most regularly, that the chalk never reaches to a height of more than 600 feet above the present surface of the sea. Another observation which Saussure has already drawn attention to, seems even still more convincing. The *flöts bjerge* is sometimes composed almost entirely of boulders of a round or oval shape, and in those places where the layers lie horizontal, these stones also lie horizontal, namely, on the side, as an egg in a liquid matter remains not on the end.

But when the deposited mountain strata have a slanting position, where for instance they slant under an angle of 45°, the long axis of these stones forms also the same angle with the horizon, and this holds good even when the strata are perpendicular.

Those *flóts* masses which rest against the higher mountain masses, were therefore not formed at that place, and in that position, which they now occupy; they have been elevated under a greater or smaller angle, at a period when the mountains on which they lean, were elevated from the bosom of the earth.

If this be granted, it is clear, that those *flóts bjerge* masses, whose layers are now in a leaning or perpendicular position on the slopes of the mountains, existed before these mountains were lifted up to their present height. But those *flóts bjergene* which stretch themselves in a horizontal position close to the foot of mountains, and are not found on mountain tops, are newer than these mountain elevations; because one cannot conceive how these elevations could have been raised without at the same time raising the already formed superincumbent strata.

Beaumont has, in his latest treatise on this subject, distinguished twelve different and distinct systems of mountains in Europe, some of which we may here mention without entering into particulars.

On *Vagufarner,* eastern side, the strata of the coal formations are oblique, whereas the Jura limestone is horizontal. This mountain-mass has thus been raised after the coal formation was deposited, but before the Jura limestone was formed.

In the *Ertzgeberge* the coal formation and Jura lime stone are both slanting, whereas the green sand and chalk are horizontal. Thus the epoch for these mountain elevations corresponds with the Jura limestone formation, but is anterior to the period of the green sands.

On the sides of the Pyrenees lie the coal formation, Jura lime, green sand, and chalk in a slanting position, whereas the tertiary formation is horizontal. This mountain chain was thus elevated after the chalk was formed.

In the Western Alps to which Mont Blanc, the highest mountain in Europe, belongs, all the tertiary formations are oblique, but the older upwashed sands are horizontal. These great and high mountain masses have thus been raised at a very late period.

The central masses of the Alps have been uplifted at a still later period; because even the older upwashed land is found in a slanting position, and only the newer upwashed sand is in its original horizontal position.

We come thus to the remarkable result, that at least in Europe, the highest mountains are those which have been the latest elevated.*

Observations on the Genus Spathium. By M. P. EDGEWORTH, ESQ.†

Happening to meet with two species of Aponogeton (Roxb.) in this neighbourhood, I compared them with the generic character of Spathium in Endlicher's Genera Plantarum, to which they are referable. I observed that he describes the embryo as unknown, and therefore, especially directed my attention to that point. By Endlicher, the

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* *Note by Prof. Schow.*—Beaumont is thereby of opinion, that those mountain chains, which are elevated at one time, are also reciprocally parallel; but this pretension can hardly be held to be proved, and there are various observations which seem to be opposed to it. This part of Beaumont's theory is therefore passed over.

† Here Mr. Edgeworth's paper is corrected and reprinted from the *Journal of the Asiatic Society*, No. 38, 1842, it being therein quite unintelligible.

As there is reason to believe that an offer made by a very competent person to correct the paper for reprint in the same Journal, did not meet with approbation from the Secretary of the Asiatic Society, an genus is referred to Saurureæ, I am therefore not a little surprised on examining the S. undulatum, to find it distinctly monocotyledonous, with a large fleshy cotyledon embracing a plumule of unusual size and development. On examining the seed of S. monostachyon, however, I found a very different structure, a homogeneous mass, in which I could find no trace of an embryo; but on causing the seeds to germinate, which they do freely in water kept in a cup, I discovered that this homogeneous mass is in reality the cotyledon and the plumule, which after an interval of some days developes itself through a slit at the base of the horn-shaped cotyledon.

Spathium undulatum likewise germinated readily. The only other point to be noticed now, is, whether these two plants are referable to one and the same genus, while so marked a difference exists in the embryo. The one with the plumule of usual size, (equalled only by the developement of that part in Nelumbium,) and the foliaceous cotyledon—the other with its plumule invisible even at the commencement of germination, and its solid cotyledon—while there are the minor differences of the ulvaceous foliage and caducous bracts of the former, as contrasted with the herbaceous foliage and persistent bracts of the latter. There is, moreover, a slight difference in the pollen of the two plants, that of the former being exactly and acutely elliptic, and assuming a globular form under the influence of acid or iodine; that of the latter gibbously

attempt is now made to do justice to the botanical labours of Mr. Edgeworth.

It is only necessary to add, that Mr. Griffith became aware of the structure of the embryo of one species, and the consequent great misplacement of the genus in question at the same time with Mr. Edgeworth, to whom he had written on the subject before Mr. Edgeworth had confided his MSS. to the care of the Secretary of the Asiatic Society.—Ed.

ovoid, and not influenced in the same manner by the iodine solution or acid.

From the description of Aponogeton pusillum in Roxburgh's Fl. Ind. and the section of the fruit of A. echinatum, in his Cor. Plants, t. 81, I should judge that they would have the same characteristics as the A. undulatum. They may perhaps be found to be intermediate, in which case the two species I have examined may be fairly considered as the extremes of a single genus. From the general habit, and the position of the bracts of Endlicher resembling that of half a floral envelope, for which reason I term them sepals in the description, the place of this genus would appear to be next to Potamogeton among the Naiades.

I have subjoined an amended generic character, and fuller descriptions of the two species I have examined.

SPATHIUM, *Loureiro.—Endlich. Gen. No.* 1826, *p.* 267.

Flores hermaphroditi, in spadice cylindraceo pedunculato spathâ mophyllâ caducâ cincto spiraliter dispositi, sessiles. *Sepala* duo, petaloidea, sub-opposita. *Stamina* sex, hypogyna; filamenta, libera, subulata, patentia, persistentia; antheræ biloculares, lateraliter dehiscentes. *Ovaria* tria (vel. 4?) rostris erectis; stigma apicale, minutum, obliquum; ovula 2-6, basi affixa, ascendentia. *Folliculi* 3 (4?) introrsum dehiscentes, 1-3 spermi; semina erecta ovata, testâ duplici, exteriore herbacea, interiore membrancea, vel evanidâ. *Embryo* exalbuminosus, macropodus, erectus, ascendens, anatropus, cotyledone magnâ, variâ, plumulâ variâ.

S. monostachyon, foliis petiolatis lineari-oblongis basi subcordatis emersis herbaceis, floribus in spadice dense confertis, sepalis persistentibus.

Descr. Rhizoma tuberosum, radicibus crassis filamentosis. Folia petiolata; petioli subtrigoni, basi membranacei interiora amplectentes; lamina linearis, obliqua, obtusa, basi subcordata, vel junior cuneata, 5 venia, venis transversalibus.

Spadix pedunculata, pedunculo cylindrico. Involucrum herbaceum caducissimum. Flores dense spiraliter dispositi, sepalis junioribus sub-imbricatis, cœruleis, basi oblique cunetais, apice subcordato-ovatis. Stam. 6, filamentis crassis, bracteis sub-longioribus, antheris cœruleis, subquadratis, bilocularibus, lateraliter dehiscentibus, polline gibbo ellipsoideo luteo. Ovaria erecta, lævia, 6-3 sperma. Semina 2-4 (2-3 abortientia) erecta, ovata, 8-costata, testâ exteriore herbaceâ, viridi, laxâ, facile separabili, interiore ad embryonem arcte adpressâ brunneâ, leviter striatâ, uno latere raphe viridi; chalazâ magna viridi.* Cotyledon solida, alba, plumula basilaris minima. Cotyledon germinans elongatur in cornu, plumula diutius basi lateraliter fisso evolvitur (folio elliptico).

S. undulatum, foliis brevi-petiolatis lineari oblongis basi cuneatis submersis ulvaceis, floribus in spadice post anthesin elongato sejunctis, sepalis caducissimis.

Descr. Rhizoma tuberosum, radicibus paucis crassis filamentosis ad apicem.

Folia radicalia, plurima petiolata, lanceolata, undulata, in petiolum decurrentia, nervo medio crasso, lateralibusque 2-4 parallelis transversalibus. Limbus plerumque petiolo longior, vernatione involutus.

Flores numerosi inspadice elongatâ dispositi, primo conferti, rachide elongatâ sparsi, ob pedunculum longissimum emersi. Spatha acuta, ante anthesin decidua. Sepala 2, sub-spathulata, basi quasi unguiculata, colorata (lacteo-alba), caducissima, ad stamina 2 lateralia opposita. Stamina 6, filamentis erectis, divaricatis, carnosis, persistentibus, anthera biloba, lateraliter dehiscente, decidua, e flavo cœrulescente, polline

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* Roxburgh describes the rachis as wood. I have not seen this appearance in any specimen I have met with.

Note.—Roxburgh describes the flowers as in S. monastachyum, but there is considerable difference between my two species. Perhaps this may not be his S. undulatum, but otherwise it fully answers his description.

luteo, acute elliptico, (in iodino vel acido globoso.) Pistilla 3, ovario superiore libero, stigmate terminale. Fructus 2, carpellis 3 follicularibus, basi subenerveis, demum divaricatis, dispermis. Semina erecta, umbilico brunneo, testâ lævi, simplice, (vel membrana exteriore tenuissima vix discreta,) raphe et chalazâ indistinctis. Embryo erectus, macropodus, cotyledone maximâ, concavâ, carnosâ, plumulam amplectente, plumulâ (in semine etiam) maximâ bifoliâ, foliis inæqualibus margine involutis.

References to the Plates, XV. *and* XVI.

a. A single flower, seen sideways.
b. Ditto from below or front, shewing the two bracts in situ.
c. Stamen.
d. A bract.
e. Imaginary section, shewing situation of parts of flower.
f. Flower after inflorescence, the capsules nearly ripe, with persistent bracts and stamens.
g and *g.* Another more magnified, and resting on the side.
h. Section of ditto, shewing its two cells placed back to back.
i and *i.* I. Pollen, gibbous at one side, much magnified—in II elliptic; *j.* globose under the influence of iodine.
k. Pistil, with small oblique terminal stigma.
l. Ditto, section shewing ovaries in situ.
m. m. Capsules.
n. Section of ditto.
o. Seed.
p. Ditto magnified, shewing the ribs of the outer-coat.
q. Ditto, outer-coat taken off, shewing the raphe and chalaza, in various veins.
r. Embryo, all the coats taken off.
s. Second coat taken off, striated, dark brown, chalaza grown transverse.

t. Section of seed, shewing the eight ribs of outer-coat.
u. Embryo section.
v. Seed, longitudinal section.
w. Germinating seed.
x. Longitudinal section of ditto.
a. Ditto further advanced.
y. I. Plumula, extracted from *a*—II. Plumula in seed before germination.
z. *y.* More magnified.
β *t* ε. Progressive states of germinating seed.
ζ Part of leaf magnified.

Extract of a Letter from FATHER JOSEPH GURY, *S. J., to his brother.*

Trichinopoly, 26th February, 1840.

"I will now add here a few words upon the cultivation of the lands. It consists almost entirely in watering them, in those places where water is to be had. Everywhere else, the country is a vast desert. The Indians, like the Swiss mountaineers, turn all their application to procuring water; but with this difference, that the Swiss bring it down from the *glaciers*, by little canals, dug along the brink of dangerous precipices; whilst the Indians, seated on the end of a beam, raise the water from the well in a bucket attached to the other end. You know what are those see-water wells: there are many of them in France. Conceive, that in the place of the large stone which serves as a counterbalance, two, three, and as many as six men are employed to raise the enormous sheet-iron bucket. When the empty bucket is to be lowered, the men approach the middle of the beam, to the extremity of which it is fixed, and when they wish to raise the water, they walk to the other end. For the purpose of avoiding the risk of falling while at work, they hold with their hands to stakes placed along the beam, which, lest their feet should slip, is indented in the manner of stairs. The person that receives the water, on its being raised, has only to spill it into the canal by which it flows over the fields. When the water is not at a great depth from the surface of the field, a more expeditious method is employed. To the bucket, two cords are attached, which are held by two men standing at each side of the well: the cords are alternately loosed and drawn, so that the bucket falling into the well, fills with water, and then being flung into the air, throws up the water into a channel for irrigation. Sometimes one man waters by himself, in which case, the place of the bucket is supplied by a deep shovel, suspended by a cord from three stakes fixed in the ground, and tied together at top. The shovel is filled by dipping it lightly in the water, which the man pours out by the movement that he communicates from the handle. In this manner, a single labourer can raise in a short time a great quantity of water.

" Malciadipatty is the chief town of the district with which I am at present charged. The name signifies a village situated at the foot of mountains; it means literally, *mountain, foot,* and *village.* The mountains here are no more than eminences, like those in Le Puy, or Besançon. They are moreover, without valleys, if I may use the expression. I mean to say, that the immense plain which composes the kingdom of Madura is broken by one of those mountains, beyond which it re-commences at the same level, which continues until interrupted by another mountain. They resemble cocks of hay placed here and there upon a meadow. In the rainy season, the water flows off like the rain from the roof of a house. The country is then inundated and intersected by large torrents. But when the rain is over, not a single current, not the smallest rivulet, is to be seen. The river Cavery itself is dry from the month of February.

" The mountains of Madura, however, though small in reality, appear, at a distance, as elevated as the Alps; and, like the Alps, they seem lost in the clouds. The flatness of the country produces this illusion. If an object exceed, by a little, the height of a man, it will be raised above the horizon, and appear greater and more distant than it really is. When you approach it, it grows small, and you are surprised how you could have taken it for any thing considerable. Thus a small hill, situated towards the east, will appear in the morning an imposing height, and to be at the distance of ten leagues: but in the evening, when the sun discovers the shrubs which cover it, it then appears such as it is in reality—a small hill, at two leagues distance. The contrary to this happens in the Alps, where the traveller, though at ten leagues from a mountain, will think that he is going to touch it with his hand.

"These optical illusions remind me of a phenomenon which is frequently seen in India, and which naturalists designate by the name of *mirage*. I have seen some singular effects from it: clouds, raised many degrees above the horizon, and perfectly resembling mountains of sand; lofty palm trees, of which I perceived only the tops, as if suspended in the air; and sometimes a fine lake, suddenly placed in the dry plains which I had just been crossing, and which, as an additional wonder, appeared to communicate with the sea. When the *mirage* appears at the horizon, it presents the aspect of the firmament, of which it seems to be but the continuation—as if the sky made a breach in the earth, crossing, to a certain extent, the foot of the trees and mountains, and allowing only their tops to be seen. When it appears in the middle of a plain, you think you see water; but it is really the aspect of the sky, produced by refraction. This water, which you suppose you see, has the property of reflecting the surrounding objects. You see their image, but not very distinctly, on account of the very great distance; for the *mirage* appears always a great way off.

"I have also had the opportunity of observing another phenomenon, which they call a *flying-star*. On sea one of them appeared which seemed to fall into the waves, lighting the entire vessel, and leaving after it a long train of light, which dazzled the sailors who were hid behind the sails. One evening, near Calléditidel, I saw, at a few paces from me, a similar meteor, which was flying and scattering on its way a quantity of brilliant sparks, exactly like a rocket, but without the hissing noise. I was in doubt for an instant whether it was a rocket. 'What fire is that?' said I to an Indian. 'It is a star,' he replied. I have seen another which, in the moment of being extinguished, resumed its brightness four or five times, advancing in bounds, but much more slowly than the ordinary flying stars.

"They are almost always followed by a train of sparks, by which their substance is wasted, and, like the rockets, they cease to be visible when it is exhausted. Such facts—would they not prove that these pretended stars are only meteors, formed by the lower regions of the atmosphere, instead of being planets, as a learned European has imagined? I did not doubt it; and I have lately acquired a new proof. I was going, by night, to visit a sick person, when I saw fall by my side the most beautiful flying-star that I ever beheld. I had full time to examine it, for its progress continued at least for ten seconds: besides the spark which it sends forth, it divided into three parts before it was extinguished. I questioned the catechist who accompanied me. He also said that it was a star. The name certainly is not well applied.—*Annals of the Propagation of the Faith.*

Extract of a Letter from FATHER SMET, *Jesuit Missionary, to the Reverend Father General of the Society.*

"University of St. Louis, 7th February, 1841.

"We arrived the 18th of May upon the banks of the *Nebrastas*, or *Stag River*, which is called by the French by the less suitable name of the *Flat River*. It is one of the most magnificent rivers of North America; from its source, which is hidden among the remotest mountains of this vast continent, to the river Missouri, to which it is tributary, it receives a number of torrents descending from the *Rocky Mountains;* it refreshes and fertilizes immense valleys, and forms at its mouth the two great geographical divisions of the upper and lower Missouri. As we proceeded up this river, scenes more or less picturesque opened upon our view. In the middle of the *Nebrastas*, thousands of islands, under various aspects, presented nearly every form of lovely scenery. I have seen some of those isles which, at a distance, might be taken for flotillas, mingling their full sails with verdant garlands, or festoons of flowers; and as the current flowed rapidly around them, they seemed, as it were, flying on the waters, thus completing the charming illusion, by this apparent motion. The tree which the soil of these islands produces in the greatest abundance is a species of white poplar, which is called cotton tree; the savages cut it in winter, and make of the bark, which appears to have a good taste, food for their horses.

"Along the banks of the river, vast plains extend, where we saw, from time to time, innumerable herds of wild goats. We saw only very few birds; but it is very perceptible that they were formerly more common in this country. Further on we met with a quantity of buffaloes' skulls and bones, regularly arranged in a semicircular form, and painted in different colours. It was a monument raised by superstition, for the *Pawnees* never undertake an expedition against the savages who may be in hostility with their tribe, or against the wild beasts of their forests, without commencing the chase, or war, by some religious ceremony performed amidst those heaps of bones. At the sight of them our huntsmen raised a cry of joy; they well knew that the plain of the buffaloes was not far off, and they expressed by those shouts the anticipated pleasure of spreading havoc among the peaceful herds.

"Wishing to obtain a commanding view of the hunt, I got up early in the morning and quitted the camp alone, in order to ascend a hillock near our tents, from which I might fully view the widely extended pasturages. After crossing some ravines, I reached an eminence, whence I descried a plain, whose radius was about twelve miles, entirely covered with wild oxen. You could not form, from any thing in your European markets, an idea of their movement and multitude. Just as I was beginning to view them, I heard shouts near me; it was our huntsmen, who rapidly rushed down upon the affrighted herd; the buffaloes fell in great numbers beneath their weapons. When they were tired with killing them, each cut up his prey, put behind him his favourite part, and retired, leaving the rest for the voracity of the wolves, which are exceedingly numerous in these places. And they did not fail to enjoy the repast. On the following night I was awakened by a confused noise, which, in the fear of the moment, I mistook for impending danger; I imagined, in my first terror, that the *Pawnees* conspired to dispute with us the passage over their lands, had assembled around our camp, and that these lugubrious cries were their signal of attack.—'Where are we?' said I, abruptly, to my guide: 'Hark ye!—Rest easy,' he replied, lying down again in his bed; 'we have nothing to fear; it is the wolves that are howling with joy; after their long winter's hunger, they are making a great meal to-night on the carcasses of the buffaloes, which our huntsmen have left after them on the plain.

" In the same place may also be seen the animal which is called *Wistonwisk* by the savages, and by travellers, the dog of the meadows, and to which I would give the name of American squirrel. It is larger than the grey squirrel, but resembles it in every other respect: its manner of moving is as animated and graceful; the colour of its skin is of a deeper brown; its teeth and claws are exactly of the same form; and its tail, shorter and less tufted, shades its pretty head. They never go alone; a secret instinct keeps them together in families. The situation of their holes is admirably chosen; it is upon the declivity of a hill, the border of a lake, or the bank of a river, and the site is always sufficiently high to secure them against any inundation, however great. The most perfect order reigns in each colony; one might say, that here is a little model-republic in the midst of the desert. Travellers, who are greatly taken with their admirable industry, and envy their undisturbed tranquillity, relate, that the sole nourishment of these little creatures consists of the grass-roots, and that the dew of heaven forms their only drink.

" On the 28th, we forded the southern arm of the river *Platte*. All the land lying between this river and the great mountains is only a heath, almost universally covered with lava and other volcanic substances. The sterile country, says a modern traveller, resembles, in nakedness and the monotonous undulations of its soil, the sandy deserts of Asia. Here no tent has ever been erected, and even the huntsman seldom appears in the best seasons of the year. At all other times the grass is withered, the streams dried up; the buffalo, the stag, and the goat, desert those dreary plains, and retire with the expiring verdure, leaving behind them a vast solitude completely uninhabited. Deep ravines, which were formerly the beds of impetuous torrents, intersect it in every direction, but now-a-days the sight of them only adds to the painful thirst which tortures the traveller. Here and there are heaps of stones, piled confusedly like ruins; ridges of rock, which rise up before you like impassable barriers, and which interrupt, without embellishing, the wearisome sameness of these solitudes. Such are the *Black Coasts;* beyond the Rocky Mountains rise the imposing land-marks of the Atlantic world. The passes and valleys of this vast chain of mountains afford an asylum to great numbers of savage tribes, many of whom are only the miserable remnants of different people who were formerly in the peaceable possession of the land, but are now driven back by war into almost inaccessible defiles, where spoliation can pursue them no further.

" This desert of the west, such as I have just described it, seem to defy the industry of civilized man. Some lands, more advantageously situated upon the banks of rivers, might, perhaps, be successfully reduced to cultivation, others might be turned into pastures as fertile as those of the East; but it is to be feared that this immense region forms a limit between civilization and barbarism, and that bands of malefactors, organized like the *Caravanes* of the Arabs, may here practise their depredations with impunity. This country will, perhaps, one day be the cradle of a new people, composed of the ancient savage races, and of that class of adventurers, fugitives, and exitles, that society has cast forth from its bosom : a heterogeneous and dangerous population, which the American Union has collected like a portentous cloud upon its frontiers, and whose force and irritation it is constantly increasing, by transporting entire tribes of Indians from the banks of the Mississippi, where they were born, into the solitudes of the west, which are assigned as their place of exile. These savages carry with them an implacable hatred towards the whites, for having, they say, unjustly driven them from their country, far from the tombs of their fathers, in order to take possession of their inheritance. Should some of these tribes hereafter form themselves into hordes, similar to the wandering people, partly shepherds, and partly warriors, who traverse with their flocks the plains of Upper Asia, is there not reason to fear, that in process of time, they with others may organize themselves into bands of pillagers and assassins, having the fleet horses of the prairies to carry them, with the desert as the scene of their outrages, and inaccessible rocks to secure their lives and plunder ?

" We beheld, on the 31st of May, one of the most remarkable curiosities of the desert; it is called the *Chimney :* it is a cone, seventy-five yards high, and about a league in circumference. It is situate upon a table-land, and has on its summit a column of petrified clay, a hundred and twenty feet high, by from twenty to forty feet broad, which has procured for it the above name. It is visible at thirty miles' distance. Upon a nearer approach, an enormous rent appears at its top, which seems to forbode its fall. At its base, some families of the tribe of the *Asbatas,* or *Large Horns,* vegetate. The rattlesnakes and dangerous reptiles that are to be met at every step, would be a scourge to the country, had not the savages discovered, in a root very common here, an infallible specific for every venomous bite.—*Annals of the Propagation of the Faith.*

The Assam Tea Plant.—We learn that the Agricultural Society of India, after having given their gold medal to Captain Charlton " as the first person to establish to the satisfaction of the Tea Committee, and its Secretary, that the Tea tree was indigenous in Assam," have also presented the same mark of honourable distinction to Major Jenkins, " for bringing to a successful result the inquiry in regard to the establishment of the Tea-plant in Assam." *What if the Assam plant should not be Tea, that is, Chinese Tea after all ?*—Gardener's Chronicle, No. 37, 1842.

Twelfth Meeting of the British Association, for the advancement of Science, Manchester, 22nd June, 1842.

The General Committee assembled at noon, Professor Whewell in the chair, when a report of the Council was read.

This document referred to the various objects of inquiry, for which premiums are offered for reports to be read at the next Meeting, which is to take place in Cork in the summer of 1843. At the recommendation of the geological section of a former Meeting, 60*l.* are to be placed at the disposal of Mr. Edward Forbes, who is to be requested to draw up a report on the Radiata and Mollusca of the Ægean and Red Seas, and the following gentlemen were formed into a Committee to report how far Zoological Nomenclature might be established on an uniform and permanent basis: Mr. Darwin, Professor Henslow, Rev. N. Jenyns, Mr. Ogilby, Mr. J. Phillips, Dr. Richardson, Mr. Strickland, (reporter,) and Mr. Westwood. Dr. Lamont of Munich, Corresponding Member of the Association, was requested to draw up a report on the system of Meteorological Observations commenced in Germany.

It was then moved by Mr. Murchison, and seconded by the Marquis of Northampton, that the thanks of the Meeting should be conveyed to the Queen for Her Majesty's grant of the Royal Observatory at Kew, for the use of the Association. The Chairman then stated, that an invitation had been sent to various scientific bodies on the Continent, requesting that delegates might be deputed on their part to attend the meeting, and that Sir John Herschel and Mr. Faraday were chosen to attend for the Academy of Modena, Professor Frisiani was present on the part of the Imperial Academy of Sciences at Milan, and that many other distinguished foreigners might be expected. The following were appointed officers of the Association :—

Trustees (Permanent) F. Baily, F.R.S. ; R. J. Murchison, F.R.S. Pres. G. S. ; J. Taylor, F.R.S. Treas. G. S. ; *President* The Right Honorable Lord F. Egerton, M.P.F.G.S. ; *Vice Presidents*, J. Delton, D.C.L. F.R.S ; the Honorable and very Rev. W. Herbert, L.L D. F.L.S. Dean of Manchester ; W. C. Henry, M.D. F.R.S. ; Sir B. Heywood, Bart. The Rev. Prof. A Sedgwick, M.A. F.R.S. G.S. ; *General Secretaries*, R. J. Murchison, F.R.S. Pres. G.S. ; Lieut. Col. Sabine, F.R.S. ; *Assistant General Secretary :* J. Phillips F.R.S. ; *General Treasurer*, J. Taylor, F.R.S. ; *Local Secretaries for the Meeting*, P. Close F.R.A.S. ; W. Fleming, M. D., J. Heywood ; F.R.S. ; *Local Treasurer for the Meeting*, Rev. J. J. Taylor, B.A. ; *Assistant Local Secretary*, S. E. Cottam, F.R.A.S.

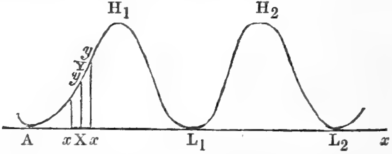
The following gentlemen were chosen Presidents of the several sections :—

A.—*Mathematical and Philosophical Science.*—The very Rev. G. Peacock, Dean of Ely.
B.—*Chemistry and Mineralogy*, John Dalton, D.C.S.
C.—*Geology and Philosophical Geography.*—R. J. Murchison, Pres. G. S.
D.—*Zoology and Botany.*—Honorable and very Rev. W. Herbert, Dean of Manchester.
E.—*Medical Science.*—Edward Holme, M.D.
F.—*Statistics.*—G. W. Wood, M. P.
G.—*Mechanical Science.*—Rev. Professor Willis.

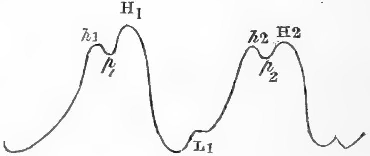
Professor Phillips then read the programme, which only differed from that of former years in making provision for sectional evening meetings, which were necessary, in order to get through the arrears of business. No excursions were arranged, but special Bolton Rail-trains were placed by the proprietors at the service of those who wished to visit the fossil trees on the Bolton line on Mondays and Wednesdays; and as it would be impossible for all to visit the various manufactories of Manchester at once, it was announced that Dr. Fleming would distribute a limited number of tickets. The accounts being next read, the meeting then adjourned. At the Mathematical section which met the following day, Sir David Brewster noticed the erection of one of Mr. Ostler's anemometers at Inverness, one of the stations at which hourly observations on the barometer and thermometer have been kept at the expense of the Association. Sir David also stated a few of the results which have attended these observations. Professor Phillips noticed the remarkable curves which the hourly observations on the barometer indicate, and pointed out the interest attached to hourly observations in connection with formulæ of barometric oscillations in different latitudes. The President, (the Dean of Ely,) considered meteorological observations as formerly kept of very little use, and thought that the hourly observations might lead to a discovery of the general laws connected with the intricate phenomena of electricity.

The further proceedings of the meeting of this section we now subjoin as reported in the *Athenæum of July 3, 1842, p.* 587-8. The reduction of the stars in the *Histoire Céleste* of M. de Lacaille therein referred to, as well as the abstract of Professor Liebig's report on organic Chemistry in the chemical section, which we also subjoin, are perhaps the subjects of most attraction in the present reports.

Mr. Scott Russell presented a 'Report on the Abnormal Tides of the Firth of Forth,' supplemental to a former Report on the same subject (*Athen.* No. 675.)—He had on a former occasion presented to the section the result of tidal observations on the Firth of Forth. These observations brought to light the existence of certain very remarkable tidal phenomena, proving the occurrence, on some parts of that Firth, of double tides, or rather perhaps of quadruple tides, being four high waters in each day, instead of only two, as usual. When this subject was formerly discussed, Mr. Russell had attributed these anomalies to the great southern tide wave entering the Firth at a different period from the great northern tide wave, to which the periods of high and low water on the east coast of Britain are principally due. But other explanations had also been suggested in quarters so high as to entitle them to great respect. For the purpose of settling this question, and, if possible, reducing these anomalous tides to some law, Mr. Russell had recently instituted second series of observations on the tides of the Firth of Forth, conducted under very careful observers, the height of the tide being observed simultaneously by different observers, at the different stations, who recorded their observations every five minutes, and continued them unceasingly night and day. They had only as yet extended over a few weeks, but already there had come out of them results of a decided character, so as to set at rest the question of the origin of these tides, and to illustrate some curious points in the history of literal tides. The tides already observed had, he thought, proved the accuracy of the theory he had formerly advanced on this subject. But it would still be desirable that these observations should be continued and extended. He then proceeded to exhibit the results of the observations in a series of accurate diagrams of the tides :—



This diagram represents the two successive tides of a day, as usually observed on the coast of Britain. The line Ax, being on the level of a given low water, is divided into equal portions, representing hours, minutes, &c., and lines perpendicular to Ax, namely, xy, XY, xy, proportioned to the successive heights, so that H_1 is high water in the morning, H_2 is high water in the evening, L_1 and L_2 being the succeeding low waters. In this case the tides exhibit the usual form, and at the mouth of the Firth they are in tolerably close accordance with it. In the upper parts of the Firth they deviate from it very widely, as in the following diagram :—



These diagrams exhibit the following changes produced in the tidal course. First of all, we have the tide rising to high water at h_1, falling to a low water at p_1, rising to a second high water at H_1, with a very small low water at p_1, between them; then we have at the low waters L_1 and L_2 an elevation, and two depressions of an equally anomalous kind. It also appears that the range or rise and fall of tide *increases* as it travels, instead of diminishing. As these observations were reduced to the same level, it further appeared that the high water mark at Stirling was higher than high water mark at Leith, by ten to fifteen feet. These diagrams, being compared with the plan of the Firth, serve to shew the effect of form of channel on the wave. Mr. Russell then proceeded to his explanation of these anomalous phenomena. He referred to the very great progress which had recently been made in our knowledge of the laws and phenomena of the tides. Mr. Lubbock had succeeded in deriving all the principal phenomena of the tides, most accurately from the equilibrium theory of Bernouilli; Mr. Whewell had constructed, from the discussion of a multitude of simultaneous observations, empirical formulæ by which the progress of the tide wave had been represented with a high degree of accuracy, and the theory of the tides had attained a high degree of perfection. But there still remained a multitude of anomalous facts for which received theory could not account, and amongst this number were these refractory double tides. Mr. Russell's theory is this: that the tidal wave is a compound wave of the first order; that its phenomena are correctly represented by the wave which he has called the great wave of translation—that this tide's motion along our shores is correctly represented by this type. Now the wave of translation in ascending a channel whose breadth and depth vary, exhibit the following phenomena:—First, a velocity varying as the square root of the depth of the channel; second, an increase of height with the diminution in breadth and in depth of the channel; third, a dislocation of the centre, which is transferred forwards in the direction of transmission according to a simple and well-established law. And these changes exactly correspond to the epoch of high water, the law of rise and fall, and the exaggeration of range in the Firth of Forth. Of the four successive high waters of each day, he has ascertained the latter tide of each pair to be *normal* and the earlier the abnormal tide. It is well known that the tide which brings high water to the east coast of Britain, as far at least as the Thames, comes round the north of Britain, and bringing high water to Aberdeen about noon, Leith about two, and London about twelve o'clock at spring tides. This wave is the same which brings to the whole of the Firth of Forth the normal high water, and of the double tides the *later* of each pair corresponds exactly with the time as predicted by the excellent tables of Mr. Lubbock. But if we conceive the great southern wave, which comes up the English Channel, to continue its course northwards in the opposite direction to the normal tide, it would enter the Forth at ten o'clock, being two hours previous to the normal tide, due to the succeeding transit of the moon, or the tide E at Leith will consist of the normal tide due to transit B and the abnormal tide due to transit A. Now the double tides are in exact correspondence with these conditions, the abnormal tide being generally about two hours in advance of the normal tide. But the circumstance which most perfectly fixes the identity of the tides, as due to the successive transits A and B, is found in the character of their diurnal irregularities. If the theory adduced be correct, the normal and the abnormal tides will have opposite inequalities. The observations made exactly correspond with this view; and so far as they go, establish the soundness of the view which has been adduced for their explanation. Another remarkable confirmation of this view is derived from the examination of the diurnal inequality of places on opposite coasts at the mouth of the Firth, the diurnal inequality on the south side being that due to the northern or normal tide, and that on the northern coast being that due to the abnormal or southern tide wave. At Leith both waves meet, and the inequalities nearly neutralize each other, and give only the difference of the inequalities. By the same process, using the wave of translation as a type of the tide wave, some further anomalies of the tide wave were explained, and the absence of all tide frequently observed on opposite and adjacent coasts, as at the north of Scotland, and the opposite coast of Norway. These are explained by the fact that the lateral transmission of the wave is slower than its transmission in the direction of its amplitude, so that the rapid advancement of one portion of the wave gives divergence to the branches, which thus separate and leave an interval of diminished tide or of no tide.

Mr. Whewell inquired, whether Mr. Russell's explanation of the double tides supposed the two waves arising from the two tide waves (the northern and southern) to be superimposed; and remarked, that in this case the difference of successive tides was so small, (only an inch or two) that it required a considerable series of observations to establish its real existence. He remarked, that the difference of the phenomena of tides on different parts of the shore of the same basin is very conspicuous in many places, and appears to confirm the view of the separate transmission of concurrent waves presented by Mr. Scott Russell, but that this doctrine is still somewhat meagre; and though it appears to account for the phenomena in the present case, must be considered as short of absolute certainty.—Mr. Holden observed that we have on the west coast in Lancashire, a mile to the north of Southport, a secondary tide, in fine calm weather. The tide comes to the height, and then retires a good way, and in fifteen minutes returns to the same height again. This secondary tide is that which comes round Ireland, and, passing through the Mull of Galloway, comes a little later to our coast.—In reply, Mr. Scott Russell stated, that he perfectly agreed with Mr. Whewell in thinking that it was desirable to have the subject ascertained by a still more extensive series of experiments, and that observations were now actually in progress with that view.—The Rev. Dr. Scoresby had frequently at sea seen several courses of waves, each pursuing its own track undeviatingly, although crossing the track of others at various angles. At the places where the crests of one series of waves crossed the crests of the waves of another series, there knots were formed, and it was this circumstance which the sailor dreaded; for if the wind blew ever so violent from one fixed quarter, it only raised one series of parallel waves, and these, however lofty, were never dreaded by the sailors; but when the wind, after blowing violently from one point, shifted suddenly a few points, a new series of parallel waves was generated, crossing the former series, and at the knots the waves accumulated the one on the other, while the trough of each deepened the trough of the other between every four knots; hence the forms of the waves also were so much deranged that the crests topped over, and breakers were formed. These cross seas were what the sailor had chiefly to dread.—Mr. Russell said that the waves of which Dr. Scoresby spoke were the oscillating waves of the sea; these were quite unlike waves of translation, of which alone he had been speaking, both in their structure and in the laws which they observed.—The President remarked, that if Mr. Russell established the fact, which he had now so ably brought before the Section, of the separate individuality, even when they had blended, of different waves of translation, so that they were capable of again separating under their proper conditions, he conceived that he had added a new and important fact to those previously established on the subject.

Mr. Dent reported 'On his Chronometrical experiment to determine the difference of Meridians between Greenwich and Devonport.'—The following are the results :—

	m.	s.	
Longitude of landing place on Breakwater by four chronometers,	16	33.60	west,
Longitude of staff on Mount Wise by Trigonometrical survey,..	16	38.1	
By mean of four chronometers, ...	16	39.8	
Difference,........		1.7	

Mr. Dent also reported respecting his Steel Balance Spring, coated with pure gold by the electro-metallurgic process; also of the performance of his clock, in which the impulse is given to the pendulum at or near the centre of percussion. By this contrivance he proposed to obviate the difficulty occasioned by the oil freezing at low temperatures. The stopping of clocks at very low temperatures had induced the Astronomer Royal to invent a *new* escapement, which seemed to answer all the conditions required; an addition of twelve pounds could be added on to the weight of the clock, and yet a variation was produced in the arc of vibration amounting to *only* five minutes, while an addition of one pound to the weight of the ordinary Graham's escapement, made a difference of fifteen minutes; by Mr. Airy's plan there was always (if the term might be used) an extra reservoir of force; keeping the train of wheels always up to their work, and capable of overcoming the resistance occasioned by the freezing of the oil. Mr. Dent then explained the principle of his patent Compensation-balance.

Mr. Frodsham made some remarks on the compensation-balance of chronometers, and explained a new compensation-balance of his invention.—Sir Thomas Brisbane said, that praise was due to Mr. Dent as the first maker who had exerted himself to determine the difference of meridians by chronometers. He had shewn, that by chronometers the difference of longitude could be had with as much certainty as by any other method in use, and at an expense bearing no proportion to that of rockets, or any other means hitherto adopted. Dr. Robinson, of Armagh, was at present engaged in a series of rocket observations in Ireland. It had been the intention of Dr. Robinson to connect the Irish with the Scotch observatories, and for that purpose a large depôt of rockets had been obtained from government, and stood in Dumbarton Castle, but unfortunately the unfavourable weather in spring had prevented the execution of the design, and he had received a letter, within a few days, from Dr. Robinson, stating that the strong twilights of the present season would make it requisite to postpone the work until autumn: these facts would at once convince the Section of the superior economy and saving of time to be attained by adopting Mr. Dent's suggestion of chronometrical observations.—Mr. Holden inquired, why the method of moon-culminating stars, which was so simple and easy of application, was not preferred to any other in determining longitudes?—Sir Thomas Brisbane replied, that to say nothing of the heavier amount of labour required in such observations, he need only, in order to shew the superiority of Mr. Dent's method, state the fact, that in a late attempt to connect the Royal Observatories of London and Paris, backed by all the instrumental accuracy and unrivalled skill of the observers at these two distinguished observatories, 300 observations on moon-culminating stars had given a mean deviating no less than thirty seconds from the truth.—The President observed, that although the method of moon-culminating stars had, in theory, promised considerable accuracy in the determinations of longitudes, yet from some unexplained difficulties it had, in practice, fallen far below the estimate that had been formed of it.

FRIDAY.

'Report of the Committee for the Reduction of the Stars in the Histoire Céleste.'

June 16, 1842.

I have the satisfaction of reporting that the whole of the stars in the *Histoire Céleste* have been reduced, agreeably to the method proposed: those only being omitted for which there are no tables of reduction, and that there is now remaining, of the grant for this purpose, the sum of 9*l*., which will not be required in the further prosecution of this portion of the work. But the main object of this undertaking will be defeated, if the catalogue be not printed for general use and information. The number of stars reduced is upwards of 47,000; and I have caused an estimate to be made of the expense of printing 500 copies in an octavo form. And it appears that the cost of paper and printing will be about 415*l*., but that 1000 copies will cost 100*l*. more. There is, however, another expense which must be taken into the account, which is the copying of the catalogue, in a proper order for the press, and the correction of the press during the printing, which I apprehend will be 60*l*. or 70*l*. more. Taking the whole of those estimates together, it would appear, that 500 copies would cost about 500*l*. and that 1000 copies would cost about 600*l*. Should the British Association decide on the printing of the catalogue, I would draw up a statement of the method pursued in making the reductions, together with such other remarks as might be requisite. This probably would not add another sheet to the work.

FRANCIS BAILY.

The President briefly pointed out to the Section the vast importance of the reduction of this valuable catalogue of stars given by Lalande, and the almost worthlessness of the catalogue without that reduction.

'Report of the Committee on the British Association Catalogue of Stars.'

I have the honor to report on the subject of this catalogue, that the calculations of the places of the stars, with the annual precessions, secular variations, and proper motions, together with the logarithms of the requisite constants, are completed for nearly 8,300 stars, which is about the number originally contemplated: that the same are fairly copied out for the press: and that the construction of the table of synonyms is now in progress, two-thirds of which are already completed: that the whole of the sum granted at the last meeting of the Association has been expended, and that a further sum of 25*l.* will be required for the completion of some of the above stars in peculiar portions, and for the final completion of the synonyms: that the above sum of 25*l.* is all that will be wanting in future, as Mr. Farley (the principal computer and superintendent) has undertaken to complete the work, ready for the press, without any further remuneration, and which will be ready for delivery in a few weeks. Under these circumstances, I have caused an estimate to be made of the expense of printing the same: and I find, that the cost of paper and printing 500 copies in quarto, will be about 550*l.*, but that 1000 copies will cost 150*l.* more. It will be requisite, however, to employ some one to correct the press, and to superintend the arrangement of the work, which will add to the expense here mentioned. A pretty large preface will be requisite, explanatory of the mode adopted in bringing up the several stars to the given epoch, and of various circumstances connected with the investigation, as well as descriptive of the method of using the catalogue in its present form. But on these points I am willing to render any assistance in my power.

FRANCIS BAILY.

'Report of the Committee for the Reduction of Lacaille's Stars.'

Collingwood, June 3, 1842.

A Committee having been appointed, consisting of myself, Mr. Henderson, and Mr. Airy, for the purpose of effecting the reduction of Lacaille's stars, I have the pleasure to report, that under the superintendence of Mr. Henderson, the whole of that work is now completed, and the resulting catalogue, being arranged in order of right ascension, is fairly written out and ready for press. The total number of stars reduced and catalogued, is about 10,000,—the sum of 105*l.* remaining of the original grant unappropriated; which the Committee recommend to be applied (with such additional grant as may be needed) to the printing and publication of the catalogue, without which, it is evident, that little or no benefit can result to Astronomical Science from the work so accomplished. With the catalogue, and forming an introduction to it, an account of the process pursued in the reductions, the constants used, and all other matter needful for a complete understanding of the work, ought also to be printed, and should it be the pleasure of the Association to order the publication, will be furnished by Mr. Henderson. The estimated cost of the publication so recommended, may be roughly stated at about 250*l.* for printing, paper, &c. of 500 copies of the catalogue and introduction.

J. F. W. Herschel.

The President observed, that the discussion and publication of these Observations upon the stars of the southern hemisphere, originally made by M. de Lacaille, now possessed an increased interest in consequence of the recent observations of Sir John Herschel, prosecuted at precisely the same locality, thus furnishing two series of observations upon the same stars at epochs separated by a very considerable interval of time.

Col. Sabine read the Report of the Committee for the translation and publication of Foreign Scientific Memoirs.

Since the last meeting of the British Association the Committee have obtained and published in the ninth number of Taylor's Foreign Scientific Journal, translations of the two following works; viz.—*Gauss*, General Propositions relating to Attractive and Repulsive Forces, acting in the inverse ratio of the square of the distance;' *Dove* 'On the Law of Storms.'—These translations were presented to the Committee by Lieut.-Col. Sabine, and as no illustrations were requisite, it has not been necessary to expend any portion of the grant placed at the disposal of the Committee.

'On the existence of a New Neutral Point, and two Secondary Neutral Points,' by Sir David Brewster.—After noticing the two neutral points (points where there is no polarization of light) of MM. Arago and Babinet, Sir D. Brewster said he had discovered a third. He also mentioned amongst some general results of observations continued for a long time, that instead of the point of maximum polarization being always, as supposed, at 90° from the sun, he had found it more frequently 88° from the sun. He also described a polarimeter or polariscope, by which, he said, the rectilinear bands in polarization were seen more clearly than by other methods.

'On certain Cases of Elliptically Polarized Light,' by Prof. Powell.—At the last meeting of the Association, Prof. Lloyd gave a *theoretical* investigation of certain results obtained by Sir D. Brewster relative to thin films from which polarized light is reflected. Besides completely explaining those results, Prof. Lloyd infers, that such films ought to give the portions of light reflected at their two surfaces differing in phase, and that the light should be consequently in general *elliptically* polarized. The author of the present paper, before he was aware of the investigation of Prof. Lloyd, had made many observations on the elliptical polarization of light by reflection from metallic and other surfaces,—the method of observation being by the well known dislocation of the polarized rings. Some of these experiments went merely to prove the existence of elliptic polarization in cases where it had not previously been detected, as in certain minerals and other bodies in which it is seen, though of small amount. In other cases the reflecting surface consisted of the thin films formed on polished metal by tarnish, by heat, or by the galvanic process of Nobili. In these instances, a verification was afforded of Prof. Lloyd's theory by *direct observation*. But, further,—these films give periodic colours; and in passing from one tint to another, the ellipticity, as disclosed by the form of the rings, underwent regular changes, passing from a dislocation in one direction to the opposite, through points of no dislocation or of plane polarization, the rings being alternately dark and bright centered. This afforded a further field for the application of theory, and Mr. Airy investigated a formula for the rings under these varying conditions, with which the phenomena are in perfect accordance.

Mr. Scott Russell communicated to the Section the results of experiments recently made by him, and which he wished to present as a supplement to the former Report of a Committee on Waves. [*Athenæum*, Nos. 517, 565, 566, 618, 675.] On former occasions he had submitted to the Section observations that were principally directed to the examination of one kind of wave, but his present communication referred to new and beautiful phenomena of a different class. Much of the difficulty experienced in attaining clear conceptions of the phenomena and mechanism of waves is to be attributed to this circumstance, that we are apt to confound with each other, under the general name of wave motion, a variety of phenomena essentially different in their origin, their form, and their laws. This essential diversity the author of this paper had formerly endeavoured to establish, more especially in the case of that species of wave which he had called the wave of translation. In this memoir of observations made in 1834-1835, he had indicated the existence and described some of the phenomena of two other classes of waves, as also in the former printed Reports of the Association. But he had lately embraced an opportunity of extending his observations, and maturing a classification, which he now submitted to the Section. Of waves there seem to be three great orders, obeying very different laws:—1. Wave of the first order,—the wave of translation,—is solitary, progressive, depending chiefly on the depth of the fluid: has two species, positive and negative. 2. The waves of the second order,—the oscillatory waves,—are gregarious; the time of oscillation depending on the amplitude of the wave: of two species, progressive and stationary. 3. The waves of the third order,—capillary waves; gregarious. The oscillation of the superficial film of a fluid, under the influence of the capillary forces, extending to a very minute depth: short in duration: of two species: free, constrained. The last of these classes he had not before minutely examined, and to them he wished to draw the attention of the Section, as amongst the phenomena which we most frequently see, and have yet failed to examine. Although these waves were noticed by the author in 1834, and figured in a memoir of his own, which drawing had since been published by M. Poncelet, in his 'Mecanique,' along with an announcement that he had observed the same waves in running water; yet they had not hitherto attracted notice or been thoroughly examined by Mr. Russell or any one else. He believed them to be the minute waves or dents indicated by the theory of Poisson; he had therefore thought it his duty to examine them. The waves of the third order were observed by Mr. Scott Russell in the following manner:—a slender brass wire was inserted vertically into a still fluid, and drawn in that position slowly along its surface. When the velocity is one foot per second the surface of the water exhibits a group of waves of great beauty and regularity, extending forwards before the exciting point, and spreading on both sides of it in the form of a con-focal group of hyperbolas; the focal distance of each hyperbola, and its assymptotes being determined by the velocity of the motion. Although the exciting point was of no more than one-sixteenth of an inch in diameter, these waves extend over several feet, and the diagrams exhibited the phenomena as having great regularity and beauty. Numerical results shewing the number of these waves in an inch of distance from the exciting point was given, and is nearly as follows:—

Velocity of moving point. Feet per min.	Number of Waves. in an inch.
55	2
60	3
65	4
72	5
80	6
90	7
103	8
120	9

These waves were examples of capillary waves, not in free but constrained motion. He had generated them in a different manner, so as to examine them in free motion, uninfluenced by the generating point, and found that the capillary waves, when moving freely, have a constant velocity of 8½ inches per second, that their duration is short, becoming insensible in about twelve seconds after describing a path not longer than eight or nine feet; in the free state, their breadth is very small at first, gradually increases, and just before vanishing attains an amplitude of nearly an inch. The capillary waves are among the phenomena we most frequently observe. It is in generating them that a gentle breeze forming over the surface of a smooth lake destroys the translucent and reflective power of the surface; they are also to be observed in all cases of primary and secondary wave motion, when the superficial film is by any cause compressed, so as to produce corrugation, and they always disappear in about twelve seconds after the exciting cause is removed. The second order of waves had also been made the subject of careful observation. A mode had been discovered of generating these waves in large groups, so that instead of observing single waves, the length of one could be deduced from the measured length of a number, thus getting the advantage of repetition of the quantity observed. It had thus been finally determined, that these oscillating waves follow Newton's law in so far that the velocities of transmission are as the square roots of the amplitudes; but the absolute velocity differs from that of Newton, so that, instead of having the wave whose period is a second of an amplitude =3.26, it is found to be =3.57. The velocities determined are as follows:—

Velocity of transmission of wave.	Amplitude.
Feet per second.	Feet.
3.01	2.65
3.16	2.94
3.29	3.125

Feet per second.	Feet.
3.37	3.26
3.57	3.57
3.72	3.913
3.84	4.20
4.16	5.00
4.62	6.25

He had also completed some further examinations of the wave of the first order, and could now present the subject in a tolerable complete form.

Prof. Braschmann inquired whether he was to understand Mr. Russell as saying, that the very beautiful method described by him, of finding the velocity of a stream, gave merely the velocity of the surface, or the mean velocity of the section.—Mr. Russell replied, merely the velocity of the surface.—Prof. Braschmann said, that in that case it could not be made available in the present state of our knowledge for enabling us to determine the mean velocity, which was what, in practice, we required, as no known relation existed between it and superficial velocity; depending as it did for its value on the configuration of the canal, and form and magnitude of the section. There existed no branch of hydraulics in a more imperfect and unsatisfactory state than this; all the approximations at present used being very rude and uncertain in their application. Prof. Whewell inquired whether Mr. Russell found the depth to which the disturbing wire was inserted into the fluid to be of any consequence.—Mr. Russell replied, not the slightest; the merest contact of the wire to the fluid produced precisely the same phenomena as its deepest insertion.—Prof. Whewell inquired how the hinder part of the curve, which these capillary waves formed at slow velocities, disappeared as the velocities increased.—Mr. Russell replied, that the hinder part of the curve drew up to the exciting wire, and at length, as the lateral branches extended, it appeared as if obliterated.—Dr. Scoresby inquired whether, as the number of waves increased with the increase of velocity, those which were most remote from the exciting wire did not diminish in height; and if so, whether they did not also increase in breadth or distance between summit and summit.—Mr. Russell replied, that to this point he had paid the earliest and most minute attention, so that he was able to assert, with the utmost confidence, that although the waves more distant from the exciting wire diminished in height, yet the wave length, or distance from summit to summit, was everywhere, at the same velocity, equal; so that in equal spaces, taken at whatever distance from the wire, the same number were always to be found, so long as the velocity remained unchanged.

THURSDAY.

SECTION B.—CHEMISTRY AND MINERALOGY.

The venerable President sat on the right hand of the chair, and left the active duties of the office to Prof. Graham.

Dr. Playfair read an abstract of Prof. Liebig's Report on Organic Chemistry, applied to Physiology and Pathology.

Dr. Playfair said, that Prof. Liebig had been requested, some few years ago, to apply himself to the consideration of questions in vegetable and animal physiology. The Professor's first Report had been read at the meeting of the Association at Glasgow, in the year 1840. The second he was about to bring before their notice. And in a third, the Professor intended to apply the principles of organic chemistry to diet and dietetics; and under this head would be comprised the nutritiveness of particular vegetables in the fattening of cattle. The first part of Prof. Liebig's Report consisted of the examination of the processes employed in the nutrition and reproduction of the various parts of the animal economy. In vegetables, as well as in animals, we recognize the existence of a force in a state of rest. It is the primary cause of growth or increase in mass of the body, in which it resides. By the action of external influences, such as by pressure of air and moisture, its condition of static equilibrium is disturbed; and entering into a state of motion or activity, it occupies itself in the production of forms. This force has received the appellation of *vital force* or *vitality*. Vitality, though residing equally in the animal and vegetable kingdoms, produces its effects by widely different instruments. Plants subsist entirely upon manures belonging to inorganic nature. Atmospheric air, the source whence they derive their nutriment, is considered to be a mineral by the most distinguished mineralogists. All substances, before they can form food for plants, must be resolved into inorganic matter. But animals, on the other hand, require highly organized atoms for nutriment. They can only subsist upon parts of an organism. They possess within them a vegetative life, as plants do, by means of which they increase in size, without consciousness on their part; but they are distinguished from vegetables, by their faculties of locomotion and sensation—faculties acting through a nervous apparatus. The true vegetative life of animals is in no way dependent upon this apparatus, for it proceeds when the means of voluntary motion and sensation are destroyed; and the most energetic volition is incapable of exerting any influence on the contractions of the heart, on the motion of the intestines, or on the process of secretion. All parts of the animal body are produced from the fluid circulating within its organism, by virtue of vitality, which resides in every organ. A destruction of the animal body is constantly proceeding. Every motion, every manifestation of force, is the result of the transformation of the structure, or of its substance. Every conception, every mental affection, is followed by changes in the chemical nature of the secreted fluids. Every thought, every sensation, is accompanied by a change in the composition of the substance of the brain. It is to supply the waste thus produced that food is necessary. Food is either applied in the increase of the mass of a structure (that is, in nutrition), or it is applied in the replacement of a structure wasted (that is, in reproduction). The primary condition for the existence of life is the reception and assimilation of food. But there is another condition equally important—the continual absorption of oxygen from the atmosphere. All vital activity results from the mutual action of the oxygen of the atmosphere and the elements of the food. All changes in matter proceeding in the body are essentially chemical, although they are not unfrequently increased or diminished in intensity by the vital force. The influence of poisons and remedial agents on the animal economy proves, that the chemical combinations and decompositions proceeding therein, and which manifest themselves in the phenomena of vitality, may be influenced by bodies having a well-defined chemical action. Vitality is the ruling agent by which the chemical powers are made to subserve its purposes; but the acting forces are chemical. It is from this view and no other, that we ought to view vitality. According to Lavoisier, an adult man takes into his system, every year, 837 lb. of oxygen, and yet he does not increase in weight. What, then, becomes of the enormous quantity of oxygen introduced in the course of the year into the human system? The carbon and hydrogen of certain parts of the body have entered into combination with the oxygen introduced through the lungs and through the skin, and have been given out in the form of carbonic acid, and the vapour of water. At every moment, with every expiration, parts of the body are thus removed, and are emitted into the atmosphere. No part of the oxygen inspired is again expired as such. Now it is found that an adult inspires 32½ oz. of oxygen daily. This will convert the carbon of 24 lb. of blood into carbonic acid. He must, therefore, take as much nutriment as will supply this daily loss; and, in fact, it is found that he does so; for the average amount of carbon in the daily food of an adult man, taking moderate exercise, is 14 oz., which require 37 oz. of oxygen for their conversion into carbonic acid. But it is obvious, as the inspired oxygen can be removed only by its conversion into carbonic acid and water, that the amount of food necessary for the support of the animal body, must be in direct ratio to the quantity of oxygen taken into the system. Thus a child, in whom the organs of respiration are naturally in a state of great activity, requires food more frequently, and in greater proportions to its bulk, than an adult, and is also less patient of hunger. A bird, deprived of food, dies on the third day; whilst a serpent, which inspires a mere trace of oxygen, can live without food for three months. The capacity of the chest in an animal, is a constant quantity. We therefore, inspire the same *volume* of air, whether at the pole or the equator. But the weight of the air, and consequently of the oxygen, varies with the temperature. Thus an adult man takes into the system daily 46,000 cubic inches of oxygen, which if the temperature be 77°, weigh 32½ oz.; but, when the temperature sinks down to the freezing point (32°), it will weigh 35 oz. Thus an adult in our climate in winter may inhale 35 oz. of oxygen; in Sicily he would inspire only 28½ oz.; and, if in Sweden, 36 oz. Hence we inspire more carbon in cold weather, when the barometer is high, than we do in warm weather; and we must consume more or less carbon in our food in the same proportion. In our own climate, the difference between summer and winter in the carbon expired, and therefore necessary for food, is as much as an eighth. Even when we consume equal weights of food, an infinitely wise Creator has so adjusted it as to meet the exigencies of climate. Thus the fruit on which the inhabitants of the south delight to feed, contains only 12 per cent. of carbon, whilst the bacon and train oil enjoyed by the inhabitants of the Arctic regions, contain from 66 to 80 per cent. of the same element. Now the mutual action between the elements of food and the oxygen of the air, *is the source of animal heat.* All living creatures, whose existence depends on the absorption of oxygen, possess within themselves a source of heat, independent of the medium in which they exist. This heat, in Professor Liebig's opinion, is wholly due to the combustion of the carbon and hydrogen contained in the food which they consume. Animal heat exists only in those parts of the body through which arterial blood (and with it oxygen in solution) circulates. The carbon and hydrogen of food, in being converted by oxygen into carbonic acid and water, must give out as much heat as if they were burned in the open air. The only difference is, that this heat is spread over unequal spaces of time; but the actual amount is always the same. The temperature of the human body is the same in the torrid as in the frigid zone. But, as the body may be considered in the light of a heated vessel, which cools with an accelerated rapidity the colder the surrounding medium, it is obvious that the fuel necessary to retain its heat must vary in different climates. Thus less heat is necessary in Palermo, where the temperature of the air is that of the human body, than in the Polar regions, where it is about 90° lower. In the animal body, the food is the fuel; and, by a proper supply of oxygen, we obtain the food given out during its combustion in winter. When we take exercise in a cold atmosphere, we respire a greater amount of oxygen, which implies a more abundant supply of carbon in the food; and, by taking this food, we form the most efficient protection against the cold. A starving man is soon frozen to death; and every one knows that the animals of prey of the Arctic regions, are far more voracious than those of the torrid zone. Our clothing is merely an equivalent for food; and the more warmly we are clothed, the less food we require. Were we to go destitute of clothes, like certain savage tribes,—or if, in hunting or fishing, we were exposed to the same degree of cold as the Samoyedes,—we could with ease consume 10lb. of flesh, and, perhaps a dozen tallow candles into the bargain, as warmly clad travellers have related, with astonishment, of those people. Then could we take the same quantity of brandy or blubber of fish, without bad effects, and learn to appreciate the delicacy of train oil. We thus perceive an explanation of the apparently anomalous habits of different nations. The maccaroni of the Italian, and the train oil of the Greenlander and the Russian, are not adventitious freaks of state, but necessary articles fitted to administer to their comfort in the climates in which they have been born. The colder the region, the more combustible must the food be. The Englishman in Jamaica perceives with regret the disappearance of his appetite, which, in England, had been a constant recurring source of enjoyment. By the use of aromatics, he creates an artificial appetite, and eats as much food as he did at home. But he thus unfits himself for the climate in which he is placed; for sufficient oxygen does not enter his system to combine with the carbon consumed; and the heat of the climate prevents him taking exercise to increase the number of his respirations. The carbon of the food is therefore forced into other channels, and disease results. England, on the other hand, sends her dyspeptic patients to southern climates. In our own land their impaired digestive organs are unable to fit the food for that state in which it best unites with the oxygen of the air, which therefore acts on the organs of respiration themselves, thus producing pulmonary complaints. But when they are removed to warmer climates, they absorb less oxygen, and take less food; and the diseased organs of digestion have sufficient power to place the diminished amount of food in equilibrium with the respired oxygen. Just as we would expect from these views, in our own climate, hepatic diseases or diseases arising from excess of carbon, are more prevalent in summer, and in winter pulmonic diseases, or those arising from an excess of oxygen. The Professor then went on to disprove the notion, that animal heat is due to nervous influence, and not to combustion—an error which had its origin in supposing that the combustion proceeds in the blood itself. He also shewed, that animal heat must not be ascribed to the contraction of the muscles. The Professor proceeds to prove, that the heat evolved by the combustion of carbon in the body is sufficient to account for the phenomena of animal heat. He shews that the 14 ounces of carbon which are daily converted into carbonic acid, in an adult, disengage no less than 197.477° of heat; a quantity which would convert 24lb. of water, at the temperature of the body, into vapour. And if we assume that the quantity of water vaporized through the skin and lungs amounts to 3lb., then we have still 146.380° of heat to sustain the temperature of the body. And when we take into calculation the heat evolved by the hydrogen of the food, and the small specific heat possessed by the organs generally, no doubt could be entertained that the heat evolved in the process of combustion, to which the food is subjected in the body, is amply sufficient to explain the constant temperature of the body. From what has preceded, it is obvious that the amount of carbon consumed in food ought to depend on the climate, density of air, and occupation of the individual. A man will require less carbon when pursuing a sedentary occupation than when he is engaged in active exercise. Prof. Liebig, having thus discussed the source of animal heat, proceeds next to consider what are the ingredients in the food, which may properly be considered to be nutritious. Physiologists conceive that the various organs in the body have originally been formed from blood. If this be admitted, it is obvious that those substances only can be considered as nutritious which are susceptible of being transformed into blood. The Professor then entered upon an examination of the composition of blood, and of the identity in chemical constitution of fibrine and albumen. The nutritive process is simplest in the case of the carnivora. This class of animals live on the blood and flesh of the graminivora, whose blood and flesh is identical with their own. In a chemical sense, therefore, a carnivorous animal, in taking food, feeds upon itself: for the nutriment is identical in composition with its own tissues. The Professor then inquired from what constituents of vegetables the blood of the graminivorous animals is produced. The nitrogenized compounds of vegetables forming the food of graminivorous animals are called vegetable fibrine, vegetable albumen, and vegetable caseine. Now, analysis has led to the interesting result, that they are exactly of the same composition in 100 parts; and, what is still more extraordinary, they are absolutely identical with the chief constituents of the blood—animal fibrine and animal albumen. By identity, be it remarked, we do not imply similarity, but absolute identity, even as far as their inorganic constituents are concerned. These considerations shewed the beautiful simplicity of nutrition. In point of fact, vegetables produce, in their inorganism, the blood of all animals. Animal and vegetable life are therefore most closely connected. The Professor has still to account for the use of the substances in food which are absolutely destitute of nitrogen; but which we know are absolutely necessary to animal life. In all these we find a great excess of carbon, and but very little oxygen. By a train of admirable reasoning, the Professor arrives at the interesting conclusion, that they are solely exhausted in the production of animal heat, being converted by the oxygen of the air into carbonic acid and water. This portion of the report contained an ingenious and important view of the use of bile in the animal economy, the truth of which quantitative physiology dare not deny. When exercise is denied to graminivorous and omnivorous animals, this is tantamount to a deficient supply of oxygen. The carbon of the food not meeting with sufficient oxygen to consume it, it passes into the compounds containing a large excess of carbon and deficiency of oxygen; or, in other words, fat is produced. Liebig concludes, that fat is altogether an abnormal and unnatural production, arising from the adaptation of nature to circumstances, and not of circumstances to nature—altogether arising from a disproportion of carbon in the food to that of oxygen respired by the lungs, or absorbed by the skin. Wild animals in a state of nature do not contain fat. The Bedouin, or Arab of the Desert, who shews with pride his lean, muscular, sinewy limbs, is altogether free from fat. And the Professor points out the diseases arising from this cause. From all that has transpired, we may sum up the nutritious elements of food as follows. The ingredients adapted for the formation of the blood, and which the Professor calls the plastic elements of nutrition, are as follows:—Vegetable fibrine, vegetable albumen, vegetable caseine, animal flesh, animal blood. The other ingredients of food being fitted to retain the temperature of the body, he calls the elements of respiration. They are—fat, starch, gum, cane sugar, grape sugar, sugar of milk, pectine, bassorine, beer, wine, spirits. These are Prof. Liebig's general principles of nutrition. The second part of the work consists of details, in which he examines the chemical processes engaged in the production of bile, of urea, uric acid and its compounds, as well as of cerebral and nervous substance. The conclusions to which he has arrived on these subjects are of such great and startling interest, that Dr. Playfair said, he dared not venture to make an abstract of them, without entering into the calculations with which they were accompanied in the Professor's explanatory remarks on digestion, he ascribes a singular function to saliva. This fluid possesses the remarkable property of enclosing air in the shape of froth, in a far higher degree even than soap suds. This air, by means of the saliva, accompanies the food into the stomach, and there its oxygen enters into combination with the constituents of the food, whilst its nitrogen is again given out through the lungs or skin. The longer digestion continues, the greater is the quantity of saliva, and consequently of air, which enters the stomach. Rumination, in certain graminivorous animals, has plainly for one object a renewed and repeated introduction of oxygen. The Professor further touches upon the use of tea and coffee as an article of food. Recent chemical research has proved, that the active principles of tea and coffee—viz. teine and caffeine—are absolutely one and the same body, perfectly identical in every respect. The action of tea and coffee on the system must be therefore the same. How is it that the practice of taking them has become necessary to whole nations? Caffeine (teine) is a highly nitrogenized body. Bile, as is well known, contains an essential nitrogenized ingredient—taurine. Now, Prof. Liebig considers, that caffeine goes to the production of this taurine; and if an infusion of tea contains only one-tenth of a grain of caffeine, still if it contribute, in point of fact, to the formation of bile, the action even of such a quantity cannot be looked upon as a nullity. Neither can it be denied, that, in case of using an excess of non-azotized food, or deficiency of motion, which is required to cause the change of matter in the tissues, and thus to yield nitrogenized matter of the bile, that in such a condition the state of health may be benefited by the use of tea or coffee, by which may be furnished the nitrogenized product produced in the healthy state of the body, and essential to the production of an important element of respiration. The American Indian, with his present habits of living solely on flesh, could not with any comfort use tea as an article of food; for his tissues waste with such rapidity that, on the contrary, he has to take something to retard this waste. And it is worthy of remark, that he has discovered in tobacco smoke a means of retarding the change of matter in the tissues of his body, and thereby of making hunger more endurable. Nor can he withstand the captivation of brandy, which, acting as an element of respiration, puts a stop to the change of matter, by performing the function which properly belongs to the products of the metamorphosed tissues. The third part of Prof. Liebig's Report treats of the recondite laws of the phenomena of motion. As it is principally of a speculative character, we can pass this over. The Professor concludes his communication by two chapters: one on the theory of disease; the other on the theory of respiration. The whole life of animals consists of a conflict between chemical forces and the vital powers. In the normal state of the body of an adult, both stand in equilibrium. Every mechanical or chemical agency which disturbs the restoration of this equilibrium is a cause of disease. Disease occurs when the resistance offered by the vital force is weaker than the acting cause of disturbance. Death is that condition in which chemical or mechanical powers gain the ascendancy, and all resistance on the part of the vital force ceases. Every abnormal condition of supply or waste may be called disease. It is evident that one and the same cause of disease—that is, of disturbance—will have different effects, according to the period of life. A cause of disease, added to the cause of waste, may in old age annihilate the resistance of the vital powers, or, in other words, occasion death; while, in the adult state, it may produce only a disproportion between supply and waste; and in infancy only an abstract state of health, *i. e.* an equilibrium between supply and waste. Prof. Liebig argues, from what has preceded, that a deficiency of resistance in a living part to the cause of waste is in fact a deficiency of resistance to the action of the oxygen of the atmosphere. The Professor's theory may be compared to a self-regulating steam-engine. The body, in regard to the production of heat and of force, acts just like one of those machines. With the lowering of the external temperature, the respiratition becomes deeper and more frequent; oxygen is supplied in greater quantity, and of greater density; the change of matter is increased, and more food must be supplied, if the temperature of the body is to remain unchanged. It has been proved, that iron is not necessary to the colouring matter of the blood, but that it forms an essential constituent of blood globules. These globules, it is well known, take no part in nutrition. Prof. Liebig conceives, that the iron is the great means of conveying to the lungs the carbonic acid formed in the system; and he has made a calculation, that the iron contained in the body could actually convey twice as much carbonic acid as is expelled daily from the system.

Mr. Solly read a paper by Prof. Schönbein, 'On the Electrolyzing Power of a Simple Voltaic Circle.' The effect of various experiments made by the learned author went to establish the fact, that voltaic effects may be produced without the solution of a metal, the usual source of voltaic actions, but by nitric and various other acids.

Mr. William Blyth read a paper 'On the Manufacture of Sulphuric Acid.'—The ordinary process of manufacturing sulphuric acid, by introducing into a leaden chamber a mixture of sulphurous acid, red nitrous fumes, and common air, has been long practised. Like many other improvements in the arts, it seems to have been more the result of chance than the application of scientific skill; and chemists remained long in the dark as to the true nature of the changes which took place in the vitriol chamber. The first satisfactory explanation was given to the world by Clement and Desormes, in 1806. These chemists discovered the white crystalline compound which is now known to be formed when sulphurous acid, red nitrous fumes, common air, and the vapour of water, are mixed together, and exposed to a sufficiently low temperature. They also observed the remarkable property which it possesses of being decomposed when put into water, and of being resolved into nitric oxide and sulphuric acid. This fact they applied to explain the important part performed by the nitric oxide, in enabling the sulphurous acid to be still farther oxydized at the expense of the oxygen in the common air. The formation of the crystalline compound in the leaden chamber, its decomposition by the weak acid at the bottom of the chamber, and the evolution of nitric oxide to be again changed into red nitrous fumes by the oxygen of the common air,—is the favourite theory of chemists at the present time, and seems to be now generally admitted. M. Adolph Rose, of Berlin, has recently published a paper on the 'Combination of Hydrated Sulphuric Acid with Nitric Oxide.' The object of the paper is to shew that the impurity in the sulphuric acid of this country, which has hitherto been considered to be nitric acid, is not nitric acid, but a combination of sulphuric acid and nitric oxide. He also shews, that this compound of sulphuric acid and nitric oxide is identical with the white crystalline formed in the vitriol chamber. There are some facts mentioned in this important paper which deserve attention; and it is more particularly the object of these remarks to bring them under the notice of those members of the Association who may be interested in the manufacture of this important acid. It is well known, that, in the making of sulphuric acid, when the acid in the chamber reaches the specific gravity of 1.450, it is impossible to go beyond this point without increasing the proportion of nitre; and even with an increased proportion of nitre, the product of acid is less than it ought to be. The reason is, that sulphuric acid, of the specific gravity of 1.450, acts very slowly in decomposing the white compound; and acid of the specific gravity of 1.500 will not act upon it at all, but, on the contrary, it has a tendency to dissolve and retain it.—Mr. Blyth demonstrated these facts by experiments.—M. Adolph Rose states, that when sulphuric acid, containing the compound, is concentrated by distillation, at one part of the process pure acid comes over; and when the acid in the retort has reached the specific gravity of 1.84, it will be found, if examined, to contain nitric oxide. It follows from this, that, when sulphuric acid is raised in the chamber above the specific gravity of 1.500, it will be found, after being rectified, more or less contaminated with the nitrous compound. He made a number of trials, to ascertain the effect of the nitrous compound upon indigo. Some of the compound was dissolved, by the aid of heat, in sulphuric acid of specific gravity 1.600. To this solution he added some drops of a strong solution of indigo in pure rectified sulphuric acid. The blue colour of the indigo was immediately destroyed. M. Adolph Rose also states, that, if rectified sulphuric acid, which is contaminated either with nitric acid or nitric oxide, be diluted with twice its bulk of water, and concentrated by distillation till it reaches the specific gravity of 1.84, the concentrated acid will be found to have been freed from both of these compounds. It follows, from this experiment, that, in order to obtain sulphuric acid sufficiently pure to be used in the preparation of sulphate of indigo, it would only be necessary to draw the acid from the chamber at a low specific gravity, not higher perhaps than 1.300 or 1.350. Rectified sulphuric acid, prepared from acid drawn from the chambers at the above strength, if found to be perfectly free from all nitrogeneous compounds, will be a great acquisition to the woollen dyer in the preparation of his sulphate of indigo; and when we consider the large quantities of acid used for this purpose, it will be admitted to be a subject of great importance.

SECTION C.—GEOLOGY AND PHYSICAL GEOGRAPHY.

1. 'On the Physical Structure of the Appalachian Chain, as exemplifying the laws which have regulated the elevation of great Mountain Chains generally,' by Professors H. D. Rogers and W. B. Rogers.

The Appalachian Chain of North America is described by the authors as consisting of a series of very numerous parallel ridges or anticlinal lines, forming a mountain belt generally 100 miles in breadth and nearly 1,200 miles in length, stretching from the South-eastern angle of Lower Canada to Northern Alabama. 1. The strata which compose this chain are the American representatives of the Silurian, Devonian, and Carboniferous systems of Europe, united into one group of conformable deposits. The general direction of the chain being N.E. and S.W., there is a remarkable predominance of S.E. dips throughout its entire length, especially in the south-eastern or most disturbed side of the belt. Proceeding north-westwards, or away from the quarter of greatest disturbance, N.W. dips begin to appear; at first few and very steep, afterwards frequent, and gradually less inclined. 2. The authors consider the frequency of dips to the S.E. or *towards* the region of intrusive rocks, accounted for by the nature of the flexures, which are not symmetric, the strata being more inclined on the N.W. than on S.E. of each anticlinal, amounting at length to a complete folding under and inversion, especially on the S.E. side of the chain, where the contortions are so closely packed as to present a uniform dip to the S.E. These folds gradually open out, the N.W. side or inverted portion of each flexure becomes vertical, or dips abruptly to the N.W.; proceeding further in this direction the dips gradually lessen, the anticlinals and troughs becoming rounder and flatter, and the intervals between the axes constantly increasing till they entirely subside at about 150 miles from the region of gneiss and intrusive rocks. The authors express their belief that a similar obliquity of the anticlinal axes will be found to obtain in *all* great mountain chains, their planes always dipping *towards* the region of chief disturbance. The inverted flexures are regarded by the authors as exhibiting simply a higher development of the same general conditions. The passage of inverted flexure into faults is stated to occur frequently, and invariably along the N.W. side of the anticlinal or S.E. of the synclinal axes; these dislocations, like the axes maintain a remarkable parallelism. 3. The axes of the Appalachian chain are distributed in natural groups, the members of each group agreeing approximately in length, curvature, amount of flexure, and distance apart. Nine principal groups are described, in five of which the axes are straight, whilst the four which *alternate* with them are curved; in two of the curved divisions the line of strike is convex to the N.W., in the other two it is convex to the S.E. In every part of the chain the axes, whether curved or straight, maintain an approximate parallelism to those of their own division, and in the minor groups within the large divisions the parallelism is still more exact. The axes vary in length from insignificant flexures to lines frequently 100 and sometimes 150 miles in length, and they deviate very little from a rectilinear course, or, as the case may be, from a uniform rate of curvature. Some of the longer curved axes exhibit a difference of strike at their extremities of 50 in a distance of 90 miles, and the rectilinear axes of different divisions vary in their line of direction as much as 60°. As all the flexures were undoubtedly formed at one period, the authors consider these facts at variance with M. Beaumont's hypothesis, that dislocations of the same geological age are parallel to one and the same meridian. 4. The general declension in level of the Appalachian strata towards the N. W., or away from the quarter of greatest local disturbance, is considered important by the authors in its bearing upon the subject of the elevation of broad continental tracts. The authors next proceed to notice memoirs, describing what they consider similar phenomena in Europe.

Theory of flexure and elevation of Strata.—From the consideration of the preceding general facts the authors have arrived at a theory which they conceive applicable to the bending and elevation of Strata generally. They state that the *oblique* form of all normal anticlinal and synclinal flexures "indicates that the force producing the dips was compounded of a wave-like oscillation and a tangential pressure;"—a purely vertical force exerted simultaneously or successively along parallel lines could only produce a series of symmetrical flexures, whilst tangential pressure, unaccompanied by a vertical force, would result in irregular contortions dependent on local irregularities in the amount of resistance. The alternate upward and downward movements necessary to enable the tangential force to bend the strata into a series of flexures, are such "as would arise from a succession of *actual waves* rolling in a given direction beneath the earth's crust." The authors observe that it would be difficult to account for the formation of grand yet simple flexures, by a repetition of feeble tangential movements, or by "a merely upward pressure, unaccompanied with pulsations on the surface of a fluid; and if this force be feeble and oft repeated, it is difficult to understand how it could return always to *the same* lines until they became conspicuous flexures." The authors suppose the strata of the region in question to have been subjected to excessive upward tension arising from the expansion of molten matter and gaseous vapours; the tension would at length be relieved by many parallel fissures formed in succession, through which much elastic vapour would escape, and, by thus removing the pressure adjacent to the lines of fracture, produce violent pulsations on the surface of the fluid below. This oscillatory movement would communicate a series of temporary flexures to the overlying crust, which would be rendered permanent by the intrusion of molten matter into the fractured strata originating the tangential force by which the flexures received their peculiar character before described. The authors do not deem it essential to this explanation that, in the production of axes of elevation, the strata should be permanently fractured to the surface. Fissures sufficient for the escape of vast bodies of elastic vapour, might open and close again superficially; and the strata may often be supported in their new position by subterranean injections not visible on the surface.

Identity of the Undulations which produced the Axes, with the wave-like motion of the Earth in Earthquakes.—The authors suppose all earthquakes to consist in oscillations of the earth's crust propagated with extreme rapidity; and they ascribe this movement to a sudden change of vertical pressure on the surface of an interior fluid mass, throwing it into wave-like undulations, such as would produce permanent flexures in the strata if more energetic, accompanied by the formation of dykes. The successive earthquakes of any region usually proceed from the same quarter, and this must also have been the case with the movements which gave rise to the parallelism of contiguous anticlinal lines. In illustration of the power of producing permanent lines of elevation which earthquakes have exhibited in modern times, the authors instance the Ullah Bund, an elevated mound extending 50 miles across the eastern arm of the Indus, which was the result of the great earthquake of Cutch in 1819; and another case recorded in 'Darwin's Journal of Travels in South America,' which a traveller described as a line of elevation of the strata, crossing a small rivulet, and shown in the fact that he found himself going down hill while ascending the dry deserted channel.

Date of the Appalachian Axes.—The authors describe the elevation of this chain as simultaneous with the termination of the carboniferous deposits of the United States, and as the cause which probably arrested the further progress of the coal formation. With one local exception, on the Hudson, the whole series seems to have been deposited conformably, without any emergence of the land. That the elevation, did not take place later, is shewn by the undisturbed condition of the overlying beds, approximately of the age of the European new red sandstone. The elevation of the chief part of the great belt of metamorphic rocks on the S.E. side of the chain is referred to the same great movement. In conclusion, the authors remark that an incomparably greater change in the physical geography of North America, and perhaps of the globe, seems to have occurred at the close of the carboniferous epoch than at any previous or subsequent period; and they consider these changes, and the effect produced by them on the organic world, as affording some of the highest subjects of geological investigation.

Mr. MURCHISON confirmed the views given by the authors of the paper, of the great break in the series of geological deposits which occurs between the Palæozoic rocks and later deposits; the coincidence in the direction of some great chains in Europe and America, belonging to the same geological period, was very striking. He was not prepared to give any opinion upon Prof. Rogers's undulatory theory.—Sir H. T. DE LA BECHE described the general character of anticlinal and synclinal lines, and stated, that whilst contortions of the strata sometimes assumed the character of mountain chains, at other times they occupied large tracts of low ground, as in the comparatively flat country of South Wales. He then made some observations on the space occupied by masses of rock over certain areas; the older rocks of England, if *flattened,* would occupy a much greater space than at present; and the area of the Alps and Jura would be greatly extended if all their contortions were spread out. The phenomena described in the Appalachian chain, so far as small differences in the direction of the anticlinals were concerned, did not at all affect the brilliant theory proposed by M. Elie de Beaumont; the object of the geologist was to trace the correspondence in the direction of the *great lines of elevation,* and in this broad view the N.E. and S.W. direction of great part of the European rocks agreed remarkably with the direction of the Appalachian chain. He did not consider the pulsation of molten matter, as described by the authors of the paper, necessary to account for the flexures so very numerous in the strata of mountainous districts, but not confined to them, and in many instances unaccompanied by the intrusion of igneous rocks. The only force necessary for the production of such flexures and contortions was, the tangential or lateral pressure, in order to compress the strata into a smaller space. Contortions were formerly accounted for by a supposed secular diminution in the volume of the earth; the crust was compelled to accommodate itself to the diminished surface arising from the contraction of the mass. But it was to be remembered, that these contortions were not common to all the world: in Russia, the strata presented one even bend over a wide area. Our knowledge of America, and much of the rest of the world, was imperfect; and until we were much better acquainted with the distribution and character of contorted strata all over the globe, we should not be able to account very rationally for the figures they assumed.—Mr. Sedgwick pointed out those circumstances in the structure of the Appalachian chain which accorded with previous observations in Europe; the persistency of the strike of the strata, the parallelism of the anticlinal and synclinal lines, and the diminution in the amount of disturbance as the strata recede from the district where the greatest force was applied. He did not allow that the circumstance of curvilinear elevations was opposed to the theory of M. Beaumont, who had himself described curved elevations quite as striking. Most of the instances adduced by Prof. Rogers, in illustration of his view of the average inclination of the strata being greater on the side of each flexure *farthest* from the centre of the disturbing forces, did not, in his opinion, confirm the view the authors had taken of the origin of those contortions. Again, Mr. Sedgwick stated, the position of the successive strata in the British chains, was not generally such as that which characterized the chain so carefully described by the authors of the paper. The effects of disturbing forces, such as the intrusion of igneous rocks, was chiefly dependent on the nature of the rocks affected. In Cumberland the porphyritic rocks, which were evidently molten when introduced, had become hard by cooling, and had been fractured and dislocated along with the rocks among which they were intruded; but from the very nature of those rocks, they could not be thrown into many undulations. In North Wales, where the conditions differed, and the igneous rocks were less abundant, the alternating beds of solid porphyry and softer rocks were thrown into a series of anticlinal and synclinal lines; whilst in the Liege country the beds, when in a very soft and plastic state, had evidently been subjected to great lateral pressure, forcing them to assume enormous contortions, but never elevating them into mountains. The authors had, he thought, rather undervalued the power of tangential forces. These were well illustrated in the effects produced upon the soft slates of North Devon, by the intrusion of masses of granite many miles across, like that forming the forest of Dartmoor, between which and other granite masses, the strata were crumpled and thrown into innumerable undulations. He believed there was very little analogy between the phenomena produced by earthquakes, and those attributed to continental elevation; the oscillations of the earth's surface produced by earthquakes were like those of a cord struck when subjected to tension: from the very nature of these vibrations, they might be propagated rapidly over a great part of the globe. The impulses of elevation, as far as anything was known of them, were slow, acting over wide areas, and disrupting and contorting mountain masses. Nothing was more certain than that continental masses had risen, and were rising, in our own time: Norway, for example, with curvations so slight as to be invisble. In the Southern and Pacific Ocean, Mr. Darwin had pointed out large areas, rising and subsiding, some of them 3,000 or 4,000 miles in diameter. He stated that he was not prepared to grapple with a theory which was so imperfectly explained, and without diagrams; he only wished phenomena not to be pressed into its service, which either bore not upon it at all, or were, perhaps, opposed to it—namely, the phenomena of the British chains. He lastly endeavoured to shew how, in many cases, a reversed dip might be produced after the first protrusion of a central granitic axis. Prof. Sedgwick concluded with a merited compliment to the American nation for the elaborate surveys they had published, of which the present memoir was an example; the facts of which must in the end, serve along with similar phenomena to form the base of a legitimate theory.

'Report of Committee appointed at the Meeting of the British Association, held at Plymouth in 1841, for Registering Shocks of Earthquakes in Great Britain.'

The Report commences with a list of shocks observed at Comrie, in Perthshire, since the date of that given in, last year, to the Association by the Committee. (*Athenæum*, No. 719.) Sixty distinct shocks are recorded as having occurred on thirty-six different days, between July 23rd, 1841, and June 8th, 1842. Twelve of these are registered as having occurred on the 30th of July, 1841, being the greatest number hitherto noticed in the course of a single day. The instruments employed to indicate the shocks were those described last year. (*Athen.* No. 719.) The new instruments provided by the Committee have not (with one exception) yet been affected, having been but a short time at their respective stations; and out of the sixty shocks above mentioned, there were but three occasions on which these instruments were moved.

1. On the 26th July, 1841, the inverted pendulum set in the steeple of Comrie parish church, was thrown about half an inch to the west, apparently indicating a horizontal movement of the ground eastward, to the same amount. An *upward* heave of the ground, to the extent of half an inch, was also indicated by two instruments, one of them being a horizontal bar, described in the course of the Report.—2. The next

shock by which the instruments were affected occurred on the 30th July, 1841. The inverted pendulum in Mr. Macfarlane's house at Comrie, vibrated to the extent of half an inch, in a direction south and north; whilst at Tomperran (about 1½ mile east of Comrie), an instrument on the principle of the common pendulum vibrated east and west. The instruments for shewing vertical movements were but slightly affected. Mr. Macfarlane describes this shock as very severe, though not so violent as that of October, 1839: estimating the former at 10, the intensity of this shock may be represented by 8. The shock was distinctly *double*, and the noise and vibrations accompanying it are described as very loud and violent, both as observed within houses and in the open air. Twelve shocks are said to have been felt in the course of the day; the weather was cold and inclined to stormy, at the time of this occurrence, and for a day or two before and after. The trees in the neighbourhood of Comrie are described as much agitated. The shock was felt eastward, at least as far as Newburgh, about 38 miles from Garrichrow; westward to Dalmally, about the same distance; as far north as Glenlion 30 miles; and southward to Alloa and Stirling, 20 or 30 miles. All the shattered chimneys noticed near Duniva, were on walls, &c. running N. and S.; those on E. and W. walls being untouched. The injured buildings stood on a gravelly soil; but the distance from rocks below was unknown. There was nothing in this weather previous to the earthquake, to give any notice of its approach; indeed, after a course of some years' observation, no exact rule in this respect has been obtained; even a period of wet weather, which was formerly thought the constant forerunner of frequent and violent shocks, is not always succeeded by them; and, on the other hand earthquakes have occurred when the sky was clear and open. The spot from which the earthquake shocks in Perthshire appear to originate, being situated about a mile to the north of Duniva, it is not difficult to understand why walls running N. and S. were affected; and those from E. to W. untouched.—3. On the 9th Sept. 1841, another pretty severe shock was felt at Comrie, about 10′ before midnight. The following morning the Association's instrument in the steeple was inclined ¾ of an inch to the south: that in the Comrie House ½ an inch to the north. This disagreement in the indication may perhaps be accounted for by the occurrence of two other shocks in the course of the night, and previously to the examination of the instruments: the weather during the two preceding days was remarkably wet and close.—4. On the 8th June, of the present year, two shocks were felt at Comrie, between 1 and 2 A.M. The horizontal pendulum recently sent to Mr. Macfarlane's house, indicated an upheave of the ground to the extent of a quarter of an inch. From a review of all the details, it seems probable that the particular spot from which the earthquakes emanate, is situated about one mile N.E. of Duniva House, and one and a half or two miles N.W. of Comrie; and it is considered desirable to place additional instruments at Duniva, and in the neighbourhood, with the view of approximating still nearer to the exact spot of emanation.

The additional instruments for indicating earthquake shocks, lately sent out, are seven in number. 1. Four of these are on the principle of the watchmaker's noddy, explained in last year's Report.—2. Another instrument consists of four horizontal glass tubes slightly turned up at each end, and filled with mercury. These tubes are laid down on the solid floor of a room, according to the points of the compass; and it is expected that when a shock takes place the mercury will flow out of one or more of these tubes. If there is no horizontal movement, but an inclination of the ground only, the mercury will flow out of the tube or tubes affected by the inclination. This instrument was made by Mr. Newman, of London, under the directions of Professor Wheatstone and Mr. D. Milne.—3. The two remaining instruments are intended exclusively to indicate vertical movements of the ground. They consist of a horizontal bar, fixed to a solid wall, by means of a strong flat watchspring, and are loaded at the opposite end. If the wall suddenly rises or sinks, the loaded end of this horizontal rod remains from its *vis inertiæ* nearly at rest, and thus can move any light substance (as paper or a straw) brought against it by the vertical movement of the ground; the light substance being so adjusted as to remain fixed wherever the rod moves it.

Beside the above instruments, a barometer, a double thermometer, and a rain-gauge, have been sent to Mr. Macfarlane, of Comrie, in order that the state of the atmosphere at the time of the shocks, and the nature of the weather generally, during their occurrence, may be ascertained. The Committee, however, think it desirable to procure instruments much more sensitive than any which they yet possess; and they particularly call attention to the importance of carrying on meteorological observations at Comrie, as there seems to exist strong grounds for the opinion entertained by many, of an intimate connexion between earthquake shocks and the state of the weather, or rather the various agents which affect the weather. The Committee have not yet attempted the registration of earthquake shocks in any part of the country expect Perthshire; but as the primitive districts of Cornwall and

Wales have often experienced shocks, they propose also to send instruments and establish observations in those parts of the country.

Dr. Buckland recommended the establishment of observations along various lines known to be affected by earthquake shocks, such as the Chichester line of fault, Swansea, and Falmouth. The electric state of the earth would probably be found to influence the atmosphere much more powerfully than the air would affect the earth; the earthquake shocks were most frequent in the autumn and winter, and it was worth inquiry how far the rains of that period would affect strata under different electric conditions, such as those brought in contact by the faults and trap dykes of Comrie, and thus, perhaps, afford some clue to the origin of the shocks.—Mr. Sedgwick believed that the small amount of evidence as to movement, which had been or could be obtained in Britain, was not likely to throw much light on the origin of earthquakes, or on their connexion with atmospheric conditions. When regular observations could be established abroad, in regions frequently and powerfully influenced by such movements we might hope to arrive at the conditious of their occurrence. Atmospheric conditions ought certainly to be noticed, and the coincidence of the shocks in Scotland with particular seasons of the year, well deserve remark. Perhaps the phenomenon was not more remarkable than the fact, that meteors showed themselves in greatest abundance during the passage of the earth through particular portions of its orbit. In saying this, however, Mr. Sedgwick did not mean to express his belief that atmospheric conditions could have any great effect on the deep-seated phenomena of earthquakes.—Sir W. T. De la Beche stated, that as a general rule the earthquakes of South America and Jamaica were felt most severely along the strike of the strata; in some instances, houses built on ranges of solid rock were affected by the shocks, whilst others only a quarter of a mile distant, built on *gravel*, entirely escaped. In all the published relations of the effects produced by earthquakes, much allowance was to be made for the excited feelings of the spectator. Thus the earthquakes which destroyed Port Royal had been described in all the exaggerated language inspired by terror; the real history was very simple; the town was built on a sand bank, encircling a number of small detached coral reefs; the violence of the waves, aided and accompanied by the concussion of the earthquake, washed away all this sand, and with it the houses, those on the coral reefs remaining as strong as before, whilst loose masses of stone, amongst the craggy rocks of the interior, naturally fell down from the effect of the same vibration.—Mr. Nicholson, of Kendal, described a slight earthquake, which had occurred on the 13th of the present month, on the shores at Morecambe Bay. The shock, which was sudden and violent, took place at 2 A. M.; there had been six weeks of drought previously, and on the day before the shock the thermometer stood at 94° in the shade, being 9° higher than it had risen in that neighbourhood since the year 1826. At 2 P. M., of the same day, the rain set in heavily. This earthquake was felt for ten miles round Kendal.

'On the Structure and Mode of Formation of Glaciers,' by James Stark, M. D.—The author stated that he employed the word glacier to signify the entire icy masses which filled the upper as well as lower valleys of snow-covered mountains, and extended downwards to the cultivated valleys or sea shore. He was induced to overlook the artificial division of these masses into *Firn*, *Mer de Glace*, &c. believing such divisions did not exist in nature, and were inapplicable to the glaciers of the Polar regions. From an examination of the accounts given by Saussure, Auldjo, Desor, and others, Dr. Stark was of opinion that there existed no constant differences in the crystalline structure of the ice in different parts of glaciers; perfect glacier ice, both as to purity and compactness, occurred at all heights; from which he inferred, that after the crystalline particles of snow became once consolidated into compact ice, no farther change, or enlargement of those particles, occurred till the mass was finally dissolved. The ice of glaciers had always been described as arranged in regular layers, but their position and mode of formation, as explained even by the latest writers, was stated by Dr. Stark to be so obscure, that having carefully examined the facts, he had formed conclusions, of which, as they differed from those usually entertained, he proceeded to give a summary, classifying the differences observable in the structure of glacial masses under the following divisions:—1. *Horizontal strata.* The author remarked that this was usually termed *banded structure,* and seemed to be confined to the upper regions of the mountains. The planes invariably coincided with the surface of the glacier, the layers being usually 1 to 3 feet in thickness. They were mentioned by almost all writers on glaciers, and represented in the plates of M. Agassiz's work. Most writers considered them as marking the annual additions to the glacier; but as the amount of snow falling on the average during the six winter months would produce a much greater thickness of ice than the horizontal layers indicated, Dr. Stark considered that each band denoted a separate fall of snow, unless it should appear that snow and ice washed with nearly as much rapidity in the upper as in the lower regions.—2. *Longitudinal and vertical strata.* Dr. Stark stated that this structure had been described by Grüner in 1760, by Desmarest in 1779, Scoresby in 1824, and other authors, and during the last winter had been claimed as a new discovery by Prof. Forbes, who styled it ribboned or banded structure. These layers he described as always of great tenuity, forming planes more or less vertical, but always parallel with the length of the glacier or its retaining walls. The explanation of this structure offered by Dr. Stark is as follows:—During the spring and summer months it is probable that glaciers advance from 1½ to 3 feet daily, and as the valleys occupied by them generally widen as they recede from the higher regions, every movement would leave a space between them and their containing walls; these fissures would continually fill up with fresh snow and ice, increasing the breadth of the glacier, and forming a new series of vertical planes. The frequent occurrence of mud, gravel, and fragments of rock in the same planes, was considered by Dr. Stark to be much in favour of this explanation of their origin. This structure, he remarked, was likely to be found wherever pillars and needles of ice were met with, since fissures and crevices generally divided glaciers transversely; and in passing over rough ground, the unequal pressure on a combination of transverse fissures and longitudinal lamellæ would break up the ice into vertical prismatic columns.—3. *Horizontal combined with longitudinal and vertical strata.* Although no such combination as this had hitherto been described, Dr. Stark thought it must exist. Horizontally stratified ice was confined to elevated regions, where the thickness of glaciers was three or four times greater than in lower valleys. Dr. Stark inferred that these beds gradually wasted away as the glacier descended, until only the lower, or vertically stratified, portion remained.—4. *Inclined strata.* This structure Dr. Stark endeavoured to explain as one superinduced, after the accidental destruction of the lines of stratification which formerly existed. In conclusion, Dr. Stark observed, that all the above forms of stratification might be expected to occur in the extent of a single glacier.

Dr. Richardson observed, that snow constantly disappeared in great quantities without melting; in dry frosty air, with a temperature below zero, it would disappear rapidly by insensible evaporation. The prismatic form of ice, which occurs on lakes where it has attained a thickness of six or eight feet, takes place only in the spring, when it begins to melt; the particles were considered to undergo a new arrangement when the temperature of the mass was elevated to the melting point.—

Col. Sabine had seen the ribboned structure of glacial ice mentioned by Prof. Forbes, but doubted whether it had ever been seen in polar ice; he had never met with it, and did not think it would have escaped his observation.

SECTION D.—ZOOLOGY AND BOTANY.

A Report was read, 'On the present state of the Ichthyology of New Zealand,' by John Richardson, M.D.—The desirableness of a report on the Zoology of that country is very great, on account of its becoming so rapidly populated, and there can be but little doubt that many of the present animal inhabitants will disappear entirely, and others will be driven from their native localities. Of the mammalia, only the dog and rat have been seen, and no snakes. This report is confined to the fishes. Very little has been added to what was made known by those who accompanied Captain Cook in his first and second voyages. They figured or described upwards of sixty-three species, to which nine have been added by Cuvier and Valenciennes, and five by other writers, making in all seventy-seven. Some of these exhibit strange forms and habits. Many are strictly *littoral* progeny of the minute crustacea which deposit their spawn in such localities. The *Beleophthalion* even ascend the beach, like little lizards, to pursue their prey. The *Plectognathi* are adapted for living in rough seas; their powers of swimming are small; some are protected with hard spines, like a hedgehog, or sea urchin, and have a power of distending their skins with air or with water, according to circumstances. Marsupial animals characterize the animal kingdom of New Holland, and the same influence seems to have acted on fish to produce a character amongst them as remarkable as the kangaroo amongst mammalia. As their organization seems to fit them for districts with little water, so does that of these fishes. During the season that the water dries up, various species of *Batrachi, Gobiodes, Cyprini*, and *Apodes*, bury themselves in the mud, and like the Lepidosiren of the Gambia, remain in an inert state till the rain falls. The sources from whence the information in this Report was obtained, are chiefly the manuscripts of Solander, with the drawings of Forster and Parkinson, now in the British Museum. A list of the species accompanied the Report, with remarks by the reporter on the more rare and singular species.

Dr. Bateman hoped that something more than information got from books would be laid before the Society, so that the existing species of animals might be referred to modern systems of classification.—Mr. Babington stated, that the object of the Report was to gain what information was scattered amongst previous writers, for the purpose of assisting future investigators.

Mr. Patterson read the substance of two Reports—the one, results of dredging at depths varying from 50 to 145 fathoms off the Mull of Galloway, by Captain Beechey, R. N., drawn up by W. Thompson, Esq.; the other, results of dredging of the Mull of Cantyre, by Mr. Hyndman and off Ballygally, county Antrim, by Mr. Patterson.

Mr. Babington read the Report of the Committee for the preservation of Animal and Vegetable Substances.—A large number of simple solutions of various salts had been tried, but, with the exception of the sub-carbonate of potash, they had all failed to preserve the specimens for any length of time. The specimens in solutions of this salt were in good condition. Substances in solutions of one part of naphtha to seven of water were in a state of good preservation. Kreosote is a good preservative, but it stains the specimens brown. Bichloride of mercury preserves well, but hardens specimens too much. Vegetable specimens were well preserved in oxalic acid, concentrated acetic acid, naphtha, and kreosote.

Mr. Moore had used Goadley's solution for the preservation of substances, and found it answer better than spirit.—Dr. Richardson had used Goadley's solution, but did not find it answer. A cheap medium for the preservation of animal substances was still a desideratum: at present, spirit he believed best.—Dr. Lankester stated that he had specimens of animal substances preserved by injecting the veins and arteries with arseniate of potash and bichloride of mercury, and the whole immersed in a strong solution of common salt. This plan was pursued in the dissecting room of Dr. A. Lizars, of Edinburgh, and enabled the students to pursue the most delicate dissections years after the death of the subject.

Mr. Moore, of Manchester, exhibited specimens of parasites found on the salmon in fresh and sea-water. They differed much in structure. The fresh-water parasite left the animal as soon as it arrived at the sea, but the parasite of the salt-water remained on the animal a long time after it reached the river. Specimens of the *Argulus foliaceus* were also exhibited, which attacked the carp in the ponds of Manchester: although they attacked the common carp, the gold and silver carp were quite free from their presence. Might not the presence of the parasites on salmon be a cause of their migration? Did their presence indicate a state of disease?

Sir W. Jardine had seen the salt-water parasite on the salmon 50 miles above the sea. The abundance of these parasites was looked upon by fishermen as an indication of the fish being in good condition. Cod were most affected by parasites when in worst condition. Other causes would account better for migration.—Dr. Lankester believed that parasites were rather the result than the cause of disease: a certain condition of the body attacked being necessary to the developement and nutrition of the parasite, and this was the case in both the vegetable and animal kingdom, and with regard to animal and vegetable parasites. When crops were attacked with blight, aphides, &c. the cause would be found in a state of the atmosphere or of the soil, which first made the plant sickly, and then gave rise to the developement of the parasite.—Mr. E. Solly, jun. thought the state of the plant might induce the action of the parasite. He wished to know if any of the members had observed that any of the artificial manures now in use had any tendency to produce plants subject to blight.—Mr. Webb Hall stated, that certain states of the atmosphere, as well as certain kinds of manuring, produced a condition in the plants of wheat, &c. which were favourable to the developement of insects and fungi upon them. He could speak to the effects of particular kinds of manure.—Mr. Babington had seen some corn, a portion of which was watered with pure water, another with nitrate of soda in solution; the result was that the latter was very much more mildewed than the former.—The Rev. J. Read observed, that it did not appear that inorganic element remained in the plants. He had watered plants with solutions of nitrate of soda, and although benefited by its influence, the ashes of these plants when analyzed did not contain more nitrate of soda than those of plants not so treated.

Dr. Richardson read a description of a new genus of fishes called *Machærium subducens.* The specimen came from Port Essington, in New Holland, and nearly resembled the *Echiodon Drummondii,* lately discovered in the Irish seas, by Mr. Thomson. This fish must be considered as a sub-generic form of Ophidium, and is very nearly related to the Blemires.

Mr. Webb Hall exhibited a specimen of the nest of a wasp, which was found attached to a twig within a deserted bee-hive. The nest was about the size of a pigeon's egg, and consisted of two globular layers of membrane, one above the other, with two apertures, the external one much smaller than the internal one. In the internal one there was a single tier of cells five or six in number, in which the ova were deposited.—Mr. Babington stated, there were many species of wasp, besides the common one, in this country, that formed pendulous nests, similar to the one now exhibited.

Mr. Blackwall read a paper on the Palpi of Spiders. It was a report of his researches with reference to this subject, since he made a communication to the Association at its meeting at Cambridge. The practical result of most consequence appeared to be that the full developement of the palpal organs indicates a state of maturity in male spiders, and this knowledge will be useful in preventing the arachnologist from falling into the too common error of mistaking young spiders for old ones, and of describing them as distinct species.

Mr. Patterson expressed a hope that Mr. Blackwall would pursue his researches, and draw up a report on the subject for their next meeting. This was acceded to by Mr. Blackwall.

Section E.—MEDICAL SCIENCE.

Dr. Sargent read a communication from Sir David Dickson, containing a report of a case of ascites with enormous distension, the abdomen containing *twenty-nine imperial quarts* of very viscid straw-coloured serum; and a case of sudden death, from the bursting of a thoracic aneurism.

Prof. Williams read a paper 'On the Construction and Application of Instruments used in Auscultation.' To express the acoustic law according to which all improvements in the stethoscope must be attempted, he deemed of great importance; and this law he stated to be, that sounds are best conducted by bodies of an elasticity or tension resembling that of the sonorous body; on the other hand, bodies differing in elasticity are bad recipients of each other's vibrations. Thus, sounds produced in air (vocal and breath sounds) are best transmitted by an enclosed column of air; those produced by solids (those of the heart, rhonchi, friction) are better communicated by rigid solids of moderate density. He proceeded to shew how these principles were applicable to explain the form and material he has adopted in the stethoscope, and detailed a number of experiments by which he demonstrates the imperfection of the proposed flexible stethoscope, which only transmitted the sounds explored through the inclosed column of air in its central cavity. On the other hand, the assertion of Dr. Cowan, though supported by Prof. Forbes, that plugging the cavity of the rigid wooden stethoscope does not materially impair its efficiency, Prof. Willliams proved, by experiment, to be erroneous; but the impairment is least when the aurile end of the instrument is plugged. In making experiments of this kind, he insisted on the necessity of having some faint sound as a test sound (as the opticians have a test object), one just within the bounds of audibility, as the sound of expiration, or a faint cardiac murmur. The necessity for an *inclosed* column of air was proved by making an opening in the side of the pectoral extremity of a common stethoscope, the efficiency of which was thus destroyed, but was instantly restored by closing the aperture. Following the assertion of acoustic writers, that the pulses of sound pass through air in straight lines, like rays of light, Prof. Williams had formerly recommended the enlargement in the pectoral extremity of the instrument to be made in the form of a straight cone, instead of the parabolic hollow used by Laennec; but subsequent experiment proved to him that a trumpet or bell-shaped termination was the best; this enlarges the surface from which the sounds are collected, without proportionally enlarging the cavity, which would give rise to a conchal or tinkling echo. Another advantage may be derived from this form of termination, in its being capable of being reversed; the aurile extremity serving to shut out diffuse sounds, when we wish to examine one spot only. Prof. Williams concluded, by making a few remarks on percussion, which he stated to be modified by the force adopted; thus, gentle and flat percussion reaches and is toned by superficial parts only, whilst, if forcible, it reaches and is toned by deep seated parts also. He stated, that the strokes differed, not only in loudness, but also in pitch, or musical tone. Disease, he stated, could frequently be detected by percussion, before auscultation gave any indication.

SECTION F.—STATISTICS.

Mr. Webb Hall read a paper by Mrs. Davies Gilbert, ‘On the results of Spade Husbandry, Small Allotments, and Agricultural Schools.’ It was a continuation of the communication made to the Section at Plymouth (*Athen.* No. 721); and shewed that small allotments cultivated by the spade were profitable to the landlord and beneficial to the labourer. Out of four hundred tenants during the space of eleven years, not one was in arrear, and not one had been brought before a magistrate. The school was self-supported, the labour of the boys paying for their education.

Mr. Porter stated that the system of small allotments and agricultural schools had been established in Ireland, and had produced most beneficial results, and that the adoption of it had been suggested by Mrs. Gilbert's communication to the Plymouth meeting.—Mr. Felkin directed the attention of the meeting to the happy condition of the Saxon weavers who have small farms on which they can fall back when manufactures are not in demand.—Messrs. Webb Hall and G. W. Wood cautioned the meeting against supposing that the introduction of this system would everywhere produce the same beneficial results which had followed its adoption in Eastbourne.

Mr. Noble read a paper 'On the Influence of the Factory System in the developement of Pulmonary Consumption.' He compared the prevalence of consumption in the manufacturing town of Manchester, with its amount in other places where there is little or no manufacture. According to the census of 1831, there were 49,932 families resident in Manchester and Salford; the entire registered deaths in 1839 were 9,223, and the cases of consumption 1,454, that is, 1 death from consumption out of every 34 families, and 3 from consumption in every 19 deaths from all causes. In agricultural Essex, with a population of 62,403 families, the deaths from consumption in 1839 were 1,201, and the total number of deaths 6,352; being, in the agricultural district, 4 in every 21, and in the factory district but as 3 in 19. In the district embracing Cambridgeshire, Huntingdonshire, and the southern divisions of Lincolnshire, comprising a population of 67,351 families, the deaths from all causes were 7,306, and those from consumption 1,308, or nearly 1 death in every 5. Thus the general mortality was lower in the agricultural districts, but the proportion of consumptive cases to deaths was greater. In Liverpool, out of 43,026 families, the deaths for 1839 were 9,181, and the deaths from consumption 1,742. Thus in Liverpool there are 2 deaths from consumption out of every 49 families, and in Manchester only two out of every 68. In Birmingham the condition was more favourable, being nearly 1 death from consumption out of every 36 families. In London the rate is 2 deaths from consumption out of every 105 families, and the proportion of consumptive cases to deaths from every cause exactly the same as Manchester, or 3 out of 19. With the exception of the metropolis, Manchester has fewer consumptive cases in proportion to the number of deaths from every cause than any of the districts above mentioned; and hence Mr. Noble inferred that factory labour has no direct tendency to produce consumptive disease. Taking the register of deaths for three years in the township of Manchester between the ages of fifteen and forty, the following results were obtained; 174 consumptive deaths were of persons employed in factories, 590 of persons registered in various occupations, and 377 without any stated employment. Of the factory operatives 45 were spinners, 49 winders, 28 piecers, 15 reelers, 11 carders and frame-tenders each, and 10 stated generally to be employed in factories. The general conclusion from these and similar facts was, that factories have no special influence in producing scrofulous disease, or its peculiar manifestation, consumption.

Dr. Alison, in a few brief remarks, confirmed generally the accuracy of Mr. Noble's views.

SECTION G.—MECHANICAL SCIENCE.

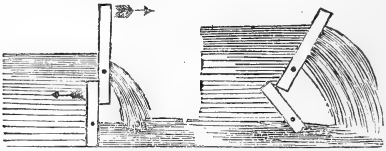
Prof. Willis, President, in the chair. After a few preliminary observations by the President, Prof. Willis, and Sir J. Robison—

Prof. Vignoles read the Report of the Committee on Railway Sections. He stated that a grant had been made by the Association of 200*l.*, for the purpose of obtaining profiles and sections of railways. Labour directed by science, and supported by commercial enterprise, laid bare the structure of highly interesting mineral districts in the deep chasms of railway cuttings; and to obtain accurate representations of these from actual observation and measurement, before they were soiled over and covered with vegetation, was the object of the Committee; and they offered these drawings as a valuable record of geology to the philosopher, and a guide to the practical engineer. Every method had been pursued which could ensure accuracy; and the drawings (which were enumerated) were to be deposited by order of the British Association in the Museum of Economic Geology, to serve as a permanent reference. In conclusion, he expressed a hope that after another year's trial of the great utility of these profiles and sections, the subject would be taken up by government, and carried out in the Geological Survey of Great Britain, now conducted by Sir H. De la Beche in conjunction with the Trigonometrical Survey under Col. Colby.

Mr. Bateman observed, that a report and drawings on the same subject were in preparation of the Manchester and Liverpool Railway. —Prof. Willis suggested that it would be desirable that all plans and drawings of this description should be laid down on the same scale, by which means greater facility of reference and comparison would be obtained.

Mr. Bateman read a paper 'On a new Self-acting Weir and Scouring Sluice,' of his invention. He remarked, that the great objections to fixed weirs and dams were, that by causing a partial stagnation in the water above them, they allowed the bed of the stream to be silted up by the deposition of mud, gravel, &c., whereas the proposed weir would adjust itself to the various changes in the condition of the stream, and prevent any filling up of the channel by making the stream clear itself. Mr. Bateman's weir is composed of two leaves turning horizontally on pivots, which are placed below the centres of the leaves, so that the upper portions of them shall be of much greater area than the lower. The upper leaf is also far larger than the lower, and turns in the direction of the stream; while the lower leaf turns against the stream, and overlaps the bottom edge of the upper leaf, and is forced against it by the pressure of the water. The comparative area of the leaves and position of the pivots is so arranged, that in ordinary states of the stream the tendency of the current to turn over the top leaf is counterbalanced by the pressure of the water against the overlap of the bottom one, the counteracting pressures keeping the weir vertical and the leaves closed, the water flowing as usual through a notch in the upper leaf. But when the water rises above the usual level, the pressure above from greater surface and leverage, overcomes the resistance below, and the top leaf turns over, pushing back the lower leaf, and thereby offering the least possible obstruction to the water, and giving a passage at the very bottom of the stream to the gravel or mud.

In answer to questions and objections, Mr. Bateman explained how difficulties, arising from trees floating down, the complete turning over of the leaves, &c., might be obviated by suitable stops, grating, &c.—Sir J. Robison observed, that the Rotterdam Canal had weirs on a similar principle; but Mr. Bateman explained that those weirs turned vertically on their axis. The following diagrams will explain the construction of the weir:—



Mr. Vignoles stated, that from the cheapness and apparent advantages of this weir, he should bring it under the consideration of the Commissioners of the Shannon Navigation, and recommend it for trial on that river, to which it appeared peculiarly applicable.

Mr. Liddell read a paper on Ventilation, on a method proposed by Mr. Fleming of Glasgow. It had been tried in a large building occupied by a number of poor persons, each family having a room. From the unclean and intemperate habits of the inmates, and their number (about 500), the house was very unhealthy, and many deaths from contagious diseases took place. In the plan adopted, the galleries were traversed by pipes of nine inches diameter, which united in a vertical pipe of large dimensions communicating with a lofty engine-house chimney; and small pipes of one inch diameter, at the top of each room, communicated with the pipes in the gallery. This plan had also been tried in the Glasgow Fever Hospital, in which the beds for fever patients, &c. were fitted up with the tubes for carrying away noxious effluvia. A similar plan for the ventilation of ships and steamers had been introduced by Dr. Reid, by leading tubes from the berths into a stove on deck, or, in steamers, into the chimney. Mr. Liddell stated that the expense for a house of 60,000 cubic feet was only 40 ℔. of coal in twenty-four hours.

Sir J. Robison remarked, that from his experience the plan of Mr. Fleming, as far as regarded the size of the pipes, was inadequate.

Prof. Vignoles made a communication on Straight Axles for Locomotives. He stated that an unfounded prejudice existed in favour of cranked axles, which, in his opinion, were inferior to straight ones in almost every point of view. With straight axles the cranks were thrown outside the wheels, which gave more room for the arrangement of the working parts; and another great advantage was gained by lowering the boiler nearly fifteen inches, and thereby increasing the safety of the engine, by placing the centre of gravity nearer the rail. The original expense of the engine and of the repairs was also much lessened. These advantages might be shown by a reference to the Dublin Kingstown Railway. By introducing straight axles and outside cranks the expenses had been greatly decreased, no accident had ever occurred from breakage; and such increase of room had been obtained, that they had placed the tender underneath the engine, thus fixing the centre of gravity as low as possible, and dispensing with the separate tender. By this arrangement they could run fifteen miles without stopping for water. He had found much difficulty in introducing the straight-axled engine on this line; and, in fact, the great obstacle in obtaining a fair trial for different forms of engines arose from the fluctuation in public opinion. Straight axles and cranked axles, four-wheeled and six-wheeled engines, had been used on different lines, not so much from the recommendations of the engineer as in compliance with the opinion of the several railway boards. Just now a prejudice existed against four-wheeled engines, as being less safe than six-wheeled, more liable to run off the line, &c. whereas he contended that the four-wheeled engine *per se* was not open to these objections. He believed that the principal advantage which could be claimed for the six-wheeled engine was in the disposition of the weight on the wheels; and a consideration of the fatal accidents which had lately occurred on the London and Brighton and the Paris and Versailles railways, would show that they arose from other causes, and had no reference to the engine having four wheels or six. He considered that both accidents arose from similar causes: in both cases heavy trains and two engines where coupled together, the smaller one leading; from some cause a check took place, the engine-man shut off the steam of the leading engine, and the following engine, with the immense momentum derived from weight and velocity, struck against it, forcing it off the rails, and causing the overturn of the carriages. It was considered objectionable to use an auxiliary engine behind a train, because, in case of any retardation of the engine in front, it cannot be checked in time to prevent great concussions of the carriages. Similar objections applied to using two engines under any circumstances, especially when of unequal power. Many accidents had taken place in consequence of the breaking of cranked axles; and M. François and Col. Aubert, in their report to the French government, had remarked that the fractures of broken axles, instead of the fibrous appearance of wrought iron, presented the crystallized appearance of cast iron, which they attributed to magnetic or electric changes in the molecular structure of the iron, caused by friction in the bearings and great velocities; and in his opinion it was probable that the continual strains and percussions to which the crank axle is subjected will account for the changes in the molecular constitution of the iron.

Mr. Hodgkinson was certain, from the results of his experiments, that a succession of strains, however slight, would produce a permanent deterioration of the elasticity of the iron—Mr. Fairbairn had been told by the engineer on the Leeds line, that he considered all crank axles to be constantly deteriorating from percussions, strains, &c, and that they should be removed and replaced by new ones periodically, to avoid danger of fracture.—A discussion arose as to whether the crystallized appearance observed in fractured axles arose from defects in the manufacture, in the quality of the iron, or from the effects of working, either by percussions, strains, or magnetic action.—Mr. Grantham, although a manufacturer of cranked axles, admitted that straight axles were less liable to break. Cranked axles, from the way in which they were welded together and shaped, were rendered weak and liable to fracture. On other grounds, however, he believed that the cranked axles were preferable, as they produced a steadier motion, and much heat was saved.—Mr. Garnett believed that more straight axles had broken than cranked ones.—Prof. Willis showed the effect of vibration in destroying molecular arrangement, by reference to the tongues in musical boxes, &c.—Mr. Nasmyth believed that the defects in axles, &c. arose in the manufacture, especially from cold swaging and hammering, and also from over-heating in welding, all of which causes injured the toughness of the iron. In small articles he found great advantage from annealing; and he believed that axles might be annealed very cheaply, and would be more servicable. He disliked the fashion of referring all unaccounted phenomena to magnetism and electricity, although he was convinced that very singular electric phenomena accompanied the transit of locomotives and the rapid generation of steam. With this was connected the non-oxidization of rails, where the traffic was in one direction, and the rapid oxydization when the same rails were travelled over in both directions, as in the Blackwall railway. He had also observed that brasses, in some cases, had from friction entered into *cold fusion*,—that is, at a heat not perceptible to the eye, a complete disintegration of the molecular structure had taken place, and he had seen the brass spread as if it had been butter or pitch. He had no doubt that this arose from electricity, but had not ascertained the fact from experiment.—Mr. Fairbairn stated, that in hand-hammered rivets the heads frequently dropped off, and presented a crystallized appearance, while those compressed by machine were sound. He found that repeated percussions, from the rivetting, hammering plates, &c., induced magnetism in iron boats.—Mr. Vignoles could not, from his experience, agree to Mr. Nasmyth's theory of the oxidization of rails by single traffic, as the railway from Newton to Wigan had been single for a long time, and was as bright as the Manchester and Liverpool. The Blackwall railway was not an analogous case, as no locomotives were employed.—Mr. Roberts disbelieved the deterioration of axles by work; he would rather trust an old axle than a new one. He believed cold swaging and hammering to be the chief causes of mischief. In fact, if axles were sent out sound and well manufactured, they would rather improve by working.

GENERAL MEETING.—THURSDAY EVENING.

Prof. Whewell, on taking the chair, referred to the honour which had been conferred on him by choosing him to preside over the meeting at Plymouth. He had now only to deliver the sceptre of authority to Lord Francis Egerton. The torch of knowledge, which was kindled by genius, had now been transferred from Plymouth to Manchester.

> Et quasi cursores musarum lampades tradunt,

which he would venture to translate—

> As in the torch-race of the Grecian youth,
> We pass from hand to hand the lamp of truth.

Having filled almost every office in the Association, he naturally felt a deep interest in its future fortunes, and particularly as to what should be done when the Association had gone the round of all the large towns of England. Hitherto, its motto had been "Fresh fields and pastures new," and no place which had been visited was superior to Manchester. Three courses seemed open to the Association: 1, the smaller towns might be visited; 2, the places where the Association had already met might be revisited; or 3, the meetings might be suspended for two or more years. He was of opinion, that while new places could be visited, it was inexpedient to repeat the cycle of visits—unless an exception might be allowed in favour of York, which had been the birth-place of the Institution. Should public interest in the Association decline, he was of opinion that it would be the wiser plan to suspend their meetings for some intervals. He believed and trusted, however, that this was still a distant prospect, and he turned to the more agreeable topic of his returning with this great scientific body to the county of his birth, and the place with which all the agreeable recollections of his childhood were connected. He felt equal pride and pleasure in being one of the many aggregated round the venerable Dalton, who had the highest name in chemistry in any part of the globe. With feelings, not less gratifying, he would now resign his place to Lord Francis Egerton, who possessed so high and well-merited a character in literature and art, and whose Presidency over a scientific association was a noble exemplification of the bond which binds together, in harmonious union, all the branches of mental cultivation.

Lord F. Egerton then took the chair, and called for the Treasurer's report.

Prof. Phillips then read the programme of the proceedings, already laid before the general committee.

Lord F. Egerton then addressed the meeting, and said—

Gentlemen,—Years have now elapsed since, by the exertions of individuals, most of whom are now present, the prototype of this meeting was held in the city of York; and so successful was that first experiment, that it has been annually repeated. The order and course of the proceedings of the body there constituted and arranged, has not, I apprehend, been strictly uniform, but I believe, on the whole, it has been usual, that on the occasion of its annual assemblage, those proceedings should be open to some observations incidental to the occasion, on the part of the President; and this preliminary duty I am anxious, to the utmost of the very limited means of my ability, to execute. In the earlier meetings of this Society, and on occasions when the office I now hold has been filled by men distinguished by scientific acquirement, it was, I believe, found possible and convenient for such Presidents to include in a preliminary discourse, a compressed but instructive statement of past proceedings and present objects The punctual and complete observance of such a practice, indeed, could not be consistent with those arrangements which admit to the occasional honour of your Presidency, individuals, selected, like myself, not for any scientific pretensions, but from the accidents of local connexion with the place, rather than the objects of the assemblage. I apprehend that other reasons of equal urgency exist, calculated to make this custom one of partial observance. The operations of this Society have grown with its growth, and expanded with its strength; and I am happy to believe that it would be difficult for the most able and instructed of those with whose knowledge I am proud, for the moment, to find my own ignorance associated, now to compress into reasonable limits, and to reduce to terms adapted to a mixed audience, a satisfactory summary of scientific proceedings, past and contemplated, connected with the labours of this Society. If, indeed, I look to the proceedings of the last year's meeting at Plymouth, I find some warrant for this supposition. You met last year, indeed, under different auspices. I cannot forget—I wish for the moment you could—how your chair was then filled and its duties discharged. Could you forget the fact, it were hardly to my interest to awaken your recollection to it, that such a man filled last year at Plymouth, an office which I now hold at Manchester. I do so for the purpose of remarking that he, more able, perhaps, than any man living in this country to give you a concise and brilliant summary of all that he and his fellow labourers are doing, forbore in his discretion from that endeavour. If he, then, who is known in matters of science to have run.

> "Through each mode of the lyre, and be master of all,"

abstained from that undertaking, I may now be excused, not for my own silence, which would require no apology, but for not calling on one of your other functionaries to supply my place for the purpose.

Slightly, indeed, before I sit down, I may presume to touch on one or two topics which I may consider immediately illustrative of the advantages of this Institution. In the first instance, however, allow me to indulge for a moment in the expression of feelings of congratulation on the subject of the particular locality which sees us here together. Guests and strangers will excuse me—inhabitants, I think, will sympathise with me, if, as a neighbour, and all but an inhabitant, I indulge in some avowal of complacency on this subject. It is not merely that to this spot from which I now address you, mechanical invention and skill have long been attracted as to one of their principal centres ; nor that a neighbourhood so rich in mineral treasures bears its own recommendation to the followers of several important branches of natural science. These, with a host of other local reasons, might well justify the selection of Manchester as a place of scientific assemblage. It has, in my opinion, a claim of equal interest as the birth-place, and still the residence and scene of the labours of one whose name is uttered with respect wherever science is cultivated, who is here to-night to enjoy the honours due to a long career of persevering devotion to knowledge, and to receive, if he will condescend to do so, from myself, the expression of my own deep personal regret, that increase of years, which to him, up to this hour, has been but increase of wisdom, should have rendered him, in respect of mere bodily strength, unable to fill, on this occasion, an office which, in his case, would have received more honour than it could confer. I do regret that any cause should have prevented the present meeting, in his native town, from being associated with the name of Dalton as its President. The Council well know my views and wishes in this matter, and that, could my services have been available, I would gladly have served as a door-keeper in any house where the father of science in Manchester was enjoying his just pre-eminence.

It is no part, as I consider it, of my present office to discuss the reasons which have induced others to suppose that I might hold it, at least, without prejudice to the interests of the Society, or of this meeting. With those who originated its efforts, who conceived its formation, and who have tended it from its cradle in York to its present vigorous maturity in Manchester, I respectfully leave my apology. In addressing to you any remarks on the objects we are met to promote, I can only do so in one way, by endeavouring to convey to you the impressions of an unscientific man—the reasons which induce me, as such, to wish success to its operations, and to defer to the judgment of those who have thought I might be of service in my present position. All readers of German literature must have observed the frequent recurrence of a word which signifies the position from which an object is viewed by the spectator—the Standtpurkt, or place of standing. My view of the vast temple of science which, raised by successive architects, is daily deriving new additions, is dim, and distant, and shadowy. Not even a proselyte of the gate, far less a Levite of the sanctuary, I cannot mould my lips to any Shibboleth of entrance; and though I fain would worship at a distance, the echo of the ritual falls too faintly on my ear to allow me to join in the service of the altar. The pile is a vast one; but who shall live to pronounce it complete? New edifices are daily arising round the central structure. Many a shaft remains to be polished, and many a capital to be elaborated into new forms of fitness and of beauty. The architects, I know, are at work. I hear with you the clink of the towel and the hammer. The builder is busy on the ground from which Bacon cleared the rubbish of centuries, and shaped the vast esplanade, the Moriah of philosophy, into a fit foundation for the subsequent erections of Newton and others. All this is going on,—I may and do congratulate you on the fact; but it is not for me to describe and particularize the progress of the labour. This will be done by the builders themselves in those sectional departments into which they have divided themselves. There the geologist will teach and learn the results of recent research and adventurous travel. Mr. Lyell is still, I believe, pursuing his investigations in the distant regions of the new World, but Mr. Murchison is returned rich with the results of his exploration of an interesting portion of the Old, and to tell you how highly and how justly such objects and such labours as his have been appreciated, how honourably to himself they have been assisted and promoted by the sovereign of those vast domains. With the political nature or extent of that sovereign's power we have here nothing to do. *Quid bellicosus Cantaber aut Scythes cogitet* is no subject for our thoughts or disquisitions; but his liberal appreciation of science, as evinced in the recent case of my friend Mr. Murchison, is worthy of our warmest acknowledgments; and I trust that those distinguished men among his subjects who have honoured us with their presence on this occasion will bear back to him evidence of the fact, that the followers of science in England duly appreciate his conduct towards their countrymen. You will learn in those Sections through what new channels the electrical inquirer has directed the fluid which Franklin snatched from Heaven, into what shapes, and what service, the grasp of science has compelled the imponderable Proteus it is his mission to enslave, to his bidding. The communication and the discussion of these past achievements, the suggestions of new methods and branches of inquiry which spring from such discussion, are among the main purposes of our meeting, and the volumes of this Society's Transactions bear ample witness to their accomplishment. We have, indeed, no longer to deal with conjecture in this respect; we have no longer an estimate to show, but an account, a profit, and a dividend. It was well for the originators of this Society to enter into calculations of prospective advantages, to fore-show that from personal intercourse and collision, light and heat would be elicited, that dormant energies might be excited in various parts of the country by the nomadic principle of this Society, that scientific operations which require simultaneous exertion on an extensive scale, might derive their necessary element of combination, and their necessary funds, from the voluntary association of men in this shape. All this it was reasonable to predict, and fortunately it is no less easy now to show that the prediction has been in all particulars of importance ratified by the result. It has been observed on more than one former occasion,—it was noticed on the last by my predecessor in the chair, and at York in 1841,—that in the whole range of physical science Astronomy was the only one which had, generally speaking, derived direct assistance from governments, or even enjoyed what I may call the patronage of society at large. It was also remarked, with equal force and truth, that many other subjects are specially in need of that species of assistance which the power of the State, or the opulence of individuals, can afford to the otherwise solitary man of science. It has come, as you well know, within the scope of the operations of this Society to endeavour, in many instances, to meet and remedy this deficiency. To the science of the stars the first rank in the table of precedence may indeed be cheerfully conceded. Let it walk first in that dignity with which its very nature invests it, but let it not walk alone. The connexion, indeed, between that science and the State, between Greenwich and Downing Street, rests now upon the soundest principles of mutual advantage. It was not always thus that the astronomer found favour and footing in the councils of statesmen and the courts of princes. Time was, when the strange delusions of judicial astrology reduced such men as Kepler to the level of Dr. Dee; and it is melancholy to think how much of such a life as Kepler's was wasted in casting the nativities of princes, and calculating the fortunes of their foolish and wicked enterprises. The sun of science has drank these mists. The telescope of a Wellington was pointed, not like that of Wallenstein from his observatory in Egra on the heavenly host, but on the frowning masses of his country's foes. He knew but one, the Homeric omen, the defence of his country, and the performance of his duty. Three centuries ago, a Mr. Airy might have been distracted from his intense and important labours at Greenwich, to mark what star was culminating at the birth of a royal infant. We do not now watch the configuration of the heavens on such events; but to that Providence which has shielded the mother, and under that Providence to the love of a loyal people we cheerfully confide the fate and fortunes of the infant hope of England: still though such delusions are swept away, it is impossible that in this maritime country the protection of the State should not in the first instance be accorded to the science which direct her fleets. Even here, as you well know, the labours of this Society have not been wanting nor inefficient. Her advice has been followed, the contribution of her friends has been accepted. It is to the suggestion and the actual assistance of this Society that the country owes the reduction of Observations now in progress under Mr. Airy; and were this the only practical result of which we had to boast, I might ask whether this were a mere trifling benefit conferred upon the nation which has accepted it at your hands. On this particular point, were it in the least degree doubtful, I might hereafter find an opportunity of appealing to Prof. Bessel, whose authority was specially quoted on a former occasion, and who will shortly be here in person to support it. Yes; and the railroad on Monday will convey in one of its carriages a most important freight. Adam Smith says, that of all luggage man is the most difficult to transport; fortunately the difficulty is not commensurate with the value of the article, weighed in the balance; but if ever accident is destined to happen on the Birmingham and Grand Junction rail-road, I hope it may be spared us on an occasion when two such companions as Herschel and Bessel are trusting their lives to its axles. May they convey to us in health and safety the illustrious stranger, the accuracy of whose observations, and the grasp of whose calculations have enabled him, if I am rightly informed, to pass the limits of our planetary system and the orbit of Uranus, to expatiate *extra flammantia mœnia,* and to measure and report the parallax and the distance of bodies, which no contrivance of optics can bring sensibly nearer to our vision—not dangling in ante-chambers, nor wiping the dust from palace staircases.

I have been speaking of matters for some time past in progress, and notorious to all who have taken an interest in your proceedings. They are gratifying as proofs that the impulse of this Society has been communicated and felt in high quarters. It is surely desirable that, under any form of government, the collective science of a country should be on the most amicable footing with the depositaries of its power; free, indeed, from undue control and interference, uncontaminated by the passions and influences with which statesmen have to deal, but enjoying its good will and favour, receiving and requiting with usury its assistance on fitting occasions, and organized in such a manner as to afford reference and advice on topics with respect to which they may be required. One more recent instance of the operations of this Society in this respect I may mention, in addition to those I have slightly enumerated. I do not refer in detail to other most important operations which owe their orgin to this Society—the Magnetic Expedition now in progress ; the extension of the trigonometrical survey on an expanded scale, suggested by you, and liberally adopted by the Board of Ordnance—these and many other similar matters are recorded in your Transactions ; and to those Transactions, rather than to any defective catalogue of mine, I would refer those who may doubt the benefit of our labours. The most recent instance, however, I cannot omit ; I mean the important accession to the means of this Society of a fixed position, a place for deposit, regulation, and comparison of instruments, and for many more purposes than I could name, perhaps even more than are yet contemplated, in the Observatory at Kew. This building was standing useless. The Council of the Association approached the throne with a petition that they might occupy it, and I am happy to say that the sceptre was gracefully held towards them ; and I think this transaction a fair instance of that species of connexion between science and government, which I hope may always be cultivated in this country. I am informed that the purposes to which this building is readily and immediately applicable, are of an importance which none but men advanced in science can appreciate. You will hear further of them in the Committee of Recommendations.

With reference to the past transactions of the Society, it would be a presumption in me to enter upon any detail. I confess, however, that on looking over the printed Transactions of the year 1839, my eye was caught by a paragraph of the introduction to Prof. Owen's treatise on the fossil reptiles of Great Britain, in which he avows that but for the assistance of the Association he should have shrunk from the undertaking of that work. The context to this passage is a vast one. Those who wish to feel the entire force of the commentary it conveys, must follow it through the pages of subtle disquisition which succeed it. I ask you, learned and unlearned alike, to give but a glance at those pages. See how the greatest—am I wrong in calling him so?—of the British disciples of Cuvier walks among the shattered remnants of former worlds, with order and arrangement in his train. Mark how, page after page, and specimen after specimen, the dislocated vertebræ fall into their places,—how the giants of former days assume their due lineaments and proportions, some shorn of the undue dimensions ascribed to them on the first flush of discovery, others expanded into even greater bulk, all alike bearing the indelible mark of adaptation to the modes of their forgotten existence, and pregnant with the proofs of wisdom and omnipotence in their common Creator. This is a portion, at least, of the results of this Society. I select it for notice, because it deals with a subject which comes partially at least, within the comprehension of those to whom algebraical formulæ or the hieroglyphics of mathematical science are a sealed letter.

Gentlemen, I have endeavoured by these remarks to convey to you the general reasons which induced me, an unscientific man, to wish this Society success, and to endeavour to assist that success by any means at my disposal. I would ask leave, before I conclude, to further illustrate these views and feelings which are incidental to my own position, by reference to a scientific transaction of no very distant date. Some two years ago, as I have understood, an adventurous and scientific party, with Prof. Agassiz at its head, undertook the ascent of that Swiss mountain, whose name indicates that it had for ages been pronounced inaccessible to the foot of man. They applied, however, to physical difficulties in this case the energies and perseverance which have won them many triumphs over intellectual obstacles, and they succeeded. I doubt not that there were many who, from the chalet and the pasturage beneath, directed their glasses to those peaks of ice, and watched with intent and thrilling interest the progress of those adventurers. Perhaps among them were some who, by some trifling incursions into those awful regions, in pursuit perhaps of the artist's or the hunter's pastime, had learned to appreciate the dangers of the crevice, the toil of the assent, cut step by step with the hatchet in the precipitous ice, and the general magnitude of the enterprise. Be assured, you climbers of the heights of science, and there are many of you here, that individuals so situated hail the progress they cannot share,—that they sympathise with your advances, lament when you are baffled; and that when you plant your flag on some hitherto virgin summit, their shout of applause would reach you from below,—if it could be conveyed to your organs by the pure and attenuated atmosphere it is yours, and yours alone, to breathe. Dwellers in the peopled valley as we are, absorbed by other cares, and I hope discharging other duties, breathers of a heavier and too often tainted atmosphere, we yet can look upwards. We watch and count your triumphs; and as you gain them, we gladly add your names to the list of those who have done honour to their country and service to their kind. For your labours have this privilege, that while their results become the common property of man, for that very reason, and because they confer that common benefit, they elevate the country in which they originate in the scale of nations, and gratify the most reasonable feelings of national pride, while they fulfil to the most unrestricted extent the obligations of our common humanity.

Mr. Murchison moved the thanks of the Association to the President for his excellent address.

The Marquis of Northampton seconded the motion, and took the opportunity of commenting on Mr. Whewell's preliminary observations. He differed from him in the expediency of suspending the meetings of the Association; he believed that every town where it had met would be glad to receive it again, and dwelt very strongly on the claims of York to receive the Association a second time. He said that the President's speech proved, that if the Sections should cease to exist, it could not be said, "carent vate sacro." He also deemed it necessary to state, that when he waited on Sir Robert Peel to urge the propriety of continuing the Magnetic Observations, which are now carried on in fifteen places, he was accompanied by the Ambassador of Russia. This was a proof of the beneficial influence of science as a bond of union between nations, and a pledge for the progress of peace and civilization.—*Athenæum, July 2nd,* 1842.

Abstract of M. Fourier's *Theory of Heat.—From "The Revolutions of the Globe Familiarly Described," by Alexander Bertrand,* M.D.

The questions relative to the temperature of the terrestrial globe, of which the ancient philosophers had a faint glimpse, were not yet susceptible of a satisfactory solution; and the human mind, on this subject, as on all those which it enters upon prematurely, veered, in succession, until these latter times, from one error to its opposite.—Thus, while Buffon, too much prepossessed with the hypothesis of a central fire yet burning beneath the cooled shell of the planetary bodies, attributed an almost exclusive influence upon the temperature of their surface to the heat which these bodies must have formerly imbibed, other physiologists, denying even the reality of this primitive heat, the existence of which every thing proves, were inclined to explain the thermometrical state of the whole globe, by the influence of the solar heat alone. Such exclusive views can no longer be admitted. It is now demonstrated, that different causes affect the temperature of the terrestrial globe, and we can even assign, with great precision, the part which each of them respectively performs.

A single individual, M. Fourier, has established, in our days the mathematical theory of heat. Making use of a method of calculation of his own invention, adapted to the new order of phenomena which he was desirous to study, he arrived at a knowledge of the laws by which they are regulated. No geometrican ever before applied mathematical analysis so profoundly to the investigation of the great phenomena of nature. No one, since Newton, has opened such new paths to the study of natural philosophy.

To give an idea of the results obtained by M. Fourier, as to the heat of the globe, will be to state the amount of all that is known upon the subject.*

" Our solar system is placed in a region of the universe, all the points of which have a common, and constant temperature, determined by the rays of light and heat which all the surrounding stars emit. This cold planetary temperature is little lower than that of the polar regions of the terrestrial globe. The earth would only have this same temperature of the heavens, if two causes did not concur to heat it; one is the continual action of the solar rays, which penetrate all its mass, and maintain the difference of climates on its surface: the other, is the interior heat which it possessed when the planetary bodies were formed, only a part of which has been dissipated at its surface.

" Let us proceed successively with these two last causes of the terrestrial heat, considering each of them, at first, separately, as if it acted alone. And first, what would have happened, if the earth, primitively possessing only the temperature of the space in which

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* The account which we are about to give, is extracted from a Memoir, inserted by M. Fourier, in the " Annales de Chimie et de Physique," (October, 1824.) If, upon some points, I have conceived it necessary to give explanations which appeared to me indispensable for the readers for whom my book is intended, in others, it seemed to me, that I could not do better than transcribe the actual expressions of M. Fourier himself. These passages are indicated by inverted commas

⁂ In a posterior note the author observes, that he should have here stated, that the thermometer used by M. Fourier, was that of Reamur, the zero, or freezing point of which, is 32°. of Farenheit, and its boiling point is marked 80, being 212°. of Farenheit.—T.

it was merged, had been, for a very great number of ages, subjected to the action of the solar rays? In order to resolve this question, we ought, evidently, to distinguish the effects produced on the extreme surface, from those which must have occurred at depths more or less considerable. As to the former, nothing is more simple."

The alternations of the presence and absence of the sun, must have, from the origin of things, occasioned diurnal and annual variations, similar to those which we now observe. Any detail upon this subject, would be superfluous. Every one comprehends, in fact, how the surface, heated by the presence of the sun above the horizon, becomes cooled every night after the setting of that orb. The cause of the annual variations is no less evident. The sun, in our climates, being each day, during the summer, a longer time above the horizon, and darting its rays more directly upon us, a more considerable heating must ensue from this double cause, than that which occurs during the winter, when the sun, notwithstanding its greater proximity to the earth, produces less effect. These phenomena, in their generality, at least, have long been the subject of scientific consideration.

We shall only observe, that the difference between the heat of the day, and that of the night, and between that of the summer and winter, as to each region, could only be explained by the consideration of the influence which the temperature of the planetary spaces exercises upon it, and which no one, before M. Fourier, ever even attempted to estimate.

The periodical effects, which we have mentioned, are remarked only at the extreme surface, and it is sufficient to penetrate a few feet beneath it to find them very sensibly modified. By virtue of a general law of nature, the strata more immediately below the surface draw from it a portion of the heat communicated by the sun; and the same effect is produced upon the successive strata to a depth which essentially depends upon the time that has elapsed since the period when the heating cause began to operate.

But the strata heated by imbibing the heat of the superficies, are not liable to the same variations of temperature as this last. To render this fact evident, let us suppose a depth, such that the heat communicated to the surface cannot reach it till several days have passed. Then clearly the diurnal variations will be no longer felt. The temperature will be there neither so hot as during the day, nor so cold as during the night, but will assume an intermediate degree, which will directly depend only upon a mean between the heat of several days, and the coldness of several nights consecutively. A thermometer placed at this depth, (that of most of our vaults) will not vary then in the space of twenty-four hours, as it would at the surface, and will remain steady, during a space of time equal to that of a season, constantly denoting a mean temperature, furnished by the aggregate of the days and nights of that season.

If we descend still lower, we shall arrive at certain strata, where the transmission of the solar heat will not be able to operate, till after a lapse of time, considerable enough to prevent the alternations of the seasons being further felt there; so that we shall then find a fixed temperature, which will be the mean between that of the seasons: that is to say, exactly that which would be obtained by taking the mean value of all the temperatures observed on the surface at each moment, during a great number of years. This fixed temperature of the deep-seated strata, being once established for each point of the earth, at a certain distance from the surface, it cannot fail (by virtue of the law, in consequence of which, a hot body brought in contact with a cold one, yields a portion of its heat to the latter), ultimately, to spread itself uniformly over every point, to the greatest depths; so that the final result of the solar influence, after a sufficient lapse of time, must be the establishment of a fixed temperature for every part of the earth, always extending itself in a similar manner, from the line where the periodical variations cease to be felt, to the centre of the earth.

It is needless to call to mind, that this fixed temperature being the result of the periodical variations of the superficies, and giving precisely, for each place, the mean value of all the temperatures which succeed each other at the surface, for a long course of years, will not change again, being once established, whatever may be the length of time during which the afflux of the solar rays is continued. In the final state which we have spoken of, all the heat which penetrates by the equatorial regions, is exactly compensated by that which passes off through the polar regions; so that the earth thus gives back to the terrestrial spaces all the heat which it received from the sun.

The final state of the mass, whose heat has pervaded all its constituent parts, is exactly comparable to that of a vessel which receives, from openings above, a constant supply of liquid, which it suffers to escape, in precisely the same quantity, by one or more orifices below. We may conclude, from what we have said, that, if the earth were exposed, for a long series of ages, to the single action of the solar rays, we should observe, below the envelope where the periodical variations operate, a constant temperature, which would be the same as to all the points of the same vertical line; that this uniform temperature would perceptibly continue to the lowest accessible depths; and would be every where equal to the temperature of the superficies; and, that, consequently, it would depend, for each point, principally on the latitude of the place at which the observations might be made.

" If the action of the solar rays had not been continued for a time sufficient to allow the heating to reach its extreme term, the temperature of deep places would not be uniform, as far as the centre of the earth, but would decrease in proportion to the descent. But, under any supposition, the influence of the solar rays could not produce a heating which augments with the depth; that is to say, which causes the deep strata to be hotter than those which are superficial."

All the preceding truths, the existence of which reasoning can only indicate, have been demonstrated by M. Fourier, with mathematical rigour. He has even given formulæ, by the assistance of which we may arrive, as regards each point, at results as precise as those which the most careful direct observation could furnish. Let us make this clearer, by an example.

We have just shewn, and we might, indeed, have assumed it as a fact, evident of itself, that the depth at which the temperature becomes constant and uniform, as respects each place, depends, among other things, on the duration of the period which occasions the same effects on the surface; that, for instance, it is necessary to penetrate lower, to withdraw from the influence of the seasons, than to cease to feel that of the day and night; but, it would be impossible to determine, by reasoning alone, the exact relation which exists between the duration of the period and the depth to which it is requisite to descend, to be beyond the reach of that influence. This relation calculation only can furnish; and that indicates, that the diurnal variations are felt only at a depth nineteen times less than those where the annual variations cease to be observed.

All the effects of the solar heat upon the earth are modified by the superposition of the atmosphere, and the presence of the waters. The great motions to which these fluids are liable, render the distribution of it more uniform. The air and the waters, besides, exercise an action of another kind upon the terrestrial heat; like transparent bodies placed upon the surface of the globe, they augment its temperature. Offering, in fact, a passage sufficiently free to the luminous heat, they present a greater obstacle to the departure of that which the earth afterwards exhales into space. The air and water thus produce nearly the same effect as ordinary glass, when surrounding a body exposed to the sun; or the effect of double sashes upon the temperature of our rooms. We proceed to another cause of the temperature of our globe.

Numerous observations, now sufficiently ascertained, prove, that, at each point of the earth, the fixed temperatures increase in proportion as we descend to the lower depths. But we have seen, that this elevation of the fixed temperature in the direction of the depth, cannot, in any way, be the consequence of the prolonged action of the rays of the sun. The cause which give to the deep strata a fixed temperature, more and more elevated, is, then, an interior source of heat, whether constant or variable, placed below these points of the globe which we have been able to reach. This cause, penetrating to the surface, raises its temperature above that which would be the result of the single action of the sun. But the increase of the temperature, communicated to the superficies by this cause, is almost nothing. This, M. Fourier has demonstrated with mathematical precision; and, it is a remarkable circumstance, that scarcely had we acquired some certainty as to the existence of a central fire, when the theory of this great geometer furnished us with the means of arriving at the most curious results, as to all the consequences to be drawn from it.

Perhaps, at first sight, it will appear surprising, that, without knowing either the nature of the focus of the internal heat, its intensity, or the depth at which it is situate, we should be able to determine any thing as to the relative influence which it is capable of exercising upon the surface. But this influence does not depend, directly, upon any of the circumstances which we have related; and in order to calculate it very closely, it is sufficient to have, 1st, the exact measure of the elevation of the temperature in the strata situated immediately below the soil; and, 2ndly, to know the degree of facility with which the heat can penetrate each of the substances which compose them. It does not, in fact, require much reflection to understand, that the central fire, whatever it may be, and whatever its position, not being able to exercise any influence upon the surface of the earth, but by the intervention of the most superficial strata, the effect which it will produce, will have an immediate and necessary relation with its mode of action on the latter; and that it will impart a greater degree of heat to the surface, the more rapidly it increases the temperature of the strata situated below it, and *vice versâ*.

Here again, what reasoning can merely indicate generally, may be determined with the greatest precision by the aid of analytical formulæ; and the assistance afforded by them, in this particular case, is such, that it is now one and the same thing with geometricians to know how much the heat increases in proportion as we dig below the ground, and to ascertain the excess of temperature which the central fire communicates to the surface; the knowledge of the one leads immediately to the knowledge of the other. Now we can measure, as to each locality, the increase of temperature, commencing from the surface; we can thus also learn, for each locality, the excess of temperature produced by the central heat.

All the observations collected and discussed by the most learned physiologists of our days, inform us, that the increase of temperature in the strata lying immediately beneath the surface, is about a degree in thirty metres, at a medium. In a globe of iron a similar increase would only give a quarter of a centesimal degree, for the actual elevation of the temperature of the surface. As a consequence of the influence of the central fire, this elevation is very trifling, and almost imperceptible; that, however, which the earth experiences is much less still. In fact, the strata of the mineral shell are not composed of iron, but of substances which offer much less facility for the transmission of heat. Now, the heating of the ground is (for the same level of temperature in the direction of the depth) directly proportioned to this facility; whence it follows that if, as is very likely, the substances of which the upper envelope of the earth is composed, conduct eight times less heat than iron, the excess of heat communicated by the internal fire will only be the 32nd part of a centesimal degree, a quantity quite insignificant.

When we examine attentively, and according to known principles, all the observations relative to the figure of the earth, we cannot doubt, that this planet received at its origin, a very elevated temperature. On the other hand, thermometrical observations shew us, that the present distribution of heat in the terrestrial envelope is that which would have occurred, if the globe had been first very hot and then progressively cooled, till it reached the state in which we now find it. The agreement of these two kinds of observations furnishes, as we may perceive, the strongest argument for the igneous origin of our planet. But, as we have just now seen, this central fire, the existence of which can scarcely now be contested, produces only imperceptible modifications on the surface of the ground.

As every thing proves, that the *other planetary bodies* have the *same origin as the earth,* we cannot doubt that the same results are applicable to them, which have been obtained with regard to our globe.

In applying this conclusion, mathematically proved, to all the planetary bodies, we find that in each the focus of heat, although still burning in the interior, is without any perceptible influence upon the temperature of the surface, whence it results that among all, the heat of the superficies must depend almost exclusively upon their distance from the sun, and the manner in which they present the different parts of their surface to the rays of that orb, as well as on the state of the superficies; the presence or absence, in particular, of an atmosphere, or of a great quantity of water on their surface, being capable of producing very sensible differences.

It is our ignorance of these latter circumstances which prevents our being able to assign, precisely, the temperature of each planet. All that we could do would be to determine, in a closely approximating manner, the degree of heat which the terrestrial globe would acquire, if placed in their respective situations. But with regard to the bodies situated at the extremities of the solar system, there is no longer any uncertainty. The impression of the Sun's rays upon these planets being extremely feeble at such a great distance, we may be assured, that the temperature of their surface is but very little above that of the planetary spaces, and consequently, that it is subject to a degree of cold incompatible with the existence of life, such as we see on the earth. This result is particularly evident with regard to Uranus, which being 660 millions of leagues distant from the sun, can derive no heat from its rays.

These considerations suffice to shew how much Buffon deviated from the truth in his conjectures upon the past, present, and future state of the temperature of the planetary bodies. The errors into which he fell, proceeded, 1st, from his being completely mistaken, as to the rapidity of the total cooling of the heated masses. He was led to suppose this rapidity to be incomparably greater than it really is. Thus he allows only 4000 years for the earth to pass from the temperature of boiling water to that which it now has; whereas 4000 years would not be sufficient to reduce this temperature the tenth of a degree. We may add, that he was not acquainted with that law of cooling, by means of which a body, with a volume as large as that of the planetary body, must necessarily be for a long time cooled at its surface, while its interior is still in a state of ignition.

2ndly.—From his assigning to the solar rays a power much too limited. Thus whilst he supposes that our earth will become uninhabitable, as soon as, by the evaporation of its internal heat, it shall be reduced to that only which would accrue to it from the sun, it is proved, on the contrary, that the heat which comes from this latter source is now nearly all that influences our climates, and that it will suffice to maintain them constantly the same, for an immense space of time. In order to produce any sensible change in our climates, whilst the surface of the earth remains the same, it would in reality be necessary, either that our sun should diminish in heat, or that our entire solar system should be transported into a region of the universe, in which the temperature of the planetary spaces would be sensibly different from that in which we are immerged.

Buffon attempted to indicate, in a precise manner, the time which would necessarily be requisite for each planetary body to pass from a state of fusion produced by heat, to a degree of cold incompatible with life. At the present day, in consequence of the theory of heat, nothing would be so easy as to resolve this question in the most precise manner; and thus to determine the age of the planets, if we had any mens of learning what was their initial temperature. But not knowing this, we can determine nothing, and must content ourselves with pointing out some results proper to give an idea of the immense time which must have elapsed since the origin of our planetary system.

M. Fourier, in endeavouring to ascertain the periods of time which similar solid bodies, similarly heated, would require to reduce them to the same state when, after having been elevated to an equal temperature, they should be immerged in the same medium, arrived at this remarkable result:—that the earth once heated to any temperature whatever, and plunged into a colder medium than itself, would cool no more in 1,280,000 years, than a globe of a foot in diameter formed of the like substances, and placed in the same circumstances, would in a second; that is to say, that in this really immense time no appreciable variation would take place in its temperature. We may see, by this result, with what slowness the general changes take place in the interior of the planets. "The duration of these grand phenomena," says M. Fourier, "corresponds with the dimensions of the universe; it is measured by numbers of the same order as those which express the distances of the fixed stars."

Once familiarized with the ideas of these prodigious numbers, we shall not be farther astonished to learn that whatever may be the influence exercised upon the surface of the ground by the internal heat, this influence will last for an unlimited time; and that more than 30,000 years will pass before it is reduced to the half of that which it now is. In truth, at the commencement of things, the variations must have been much more rapid; but from the most remote historical times, all these great phenomena relative to the earth have assumed a character of stability which is very remarkable. It is rigorously demonstrated that, from the time of the Greek school of Alexandria to the present day, the temperature of the terrestrial surface has not diminished, in consequence of the declining of its internal heat, the 300dth part of a degree of heat of the terrestrial globe.

From these different reflections, we conclude that, after having diminished for an immense length of time, the influence of the internal heat of the globe, however intense it may be, produces only an imperceptible effect on the surface; and that this effect, feeble as it is, will not, however, be totally destroyed till after an unlimited time, for strictly speaking, it will become more and more feeble, until the internal heat be wholly dissipated.

Although the effect of the interior heat may not be any longer sensible at the surface of the earth, the total quantity dissipated in a given time, as a year or a century, can be measured; and M. Fourier, who has ascertained it, has shewn that it was once more considerable. That which traverses a square metre in superficies, and is in the course of a century dispersed into the planetary spaces, could melt a column of ice which should have for its base this square metre, and a height of about three metres.

The same geometrician has ascertained the quantity of heat, the oscillations of which determine the alternation of the seasons, for every point of the globe. This quantity, supposing the terrestrial envelope to be made of forged iron, would be, for every square metre of superficies, equivalent to that which would melt a cylindrical column, having for its base this square metre, and three metres of height: that is to say, that the quantity of heat which every year produces the alternation of the seasons, would be on this supposition, perceptibly equal to that which the terrestrial globe loses in a century, in consequence of the evaporation of its internal heat: but the envelope of the terrestrial globe being formed of substances, which conduct the heat in a much less degree than forged iron would do, the annual loss is really less considerable.

It is of great importance to observe, that the mean temperature may experience, from accidental causes, variations incomparably more evident than those which arise from the secular cooling of the globe.

The establishment and progress of human societies, and the action of the ordinary powers of nature, may change, more especially in very extensive countries, the state of the surface of the ground, the distribution of the waters, and the great movements of the atmosphere. Such effects are calculated to produce a very sensible variation in the amount of the mean heat, in the course of a few years. In general, the clearing and cultivation of the lands, the establishment of towns, the operations by which a settled course is given to streams and rivers, the drying up of marshes—in a word, all that ensues from the progress of civilization, tends to augment the temperature of a country. This would appear to have formerly happened to Germany, which, in the time of Tacitus, was much colder than in our days; and very recently in the United States, the climate of which would seem to have been very evidently softened during the last half century.* These incontestable facts, which appear, at first sight, to contradict the hypothesis of the gradual cooling of the terrestrial globe, clearly prove nothing against it, since they depend on local causes, the amount of which the theory of heat can appreciate with sufficient exactness, while that same hypothesis proves, as we have seen, that the influence of the central fire is nearly nothing on the surface.

We shall now consider a third cause of the terrestrial heat, which consists in the temperature of the planetary spaces. Suppose, for an instant, that the sun, and all the planetary bodies should cease to exist, the region of the heavens occupied by our solar system, would have a certain temperature, which a thermometer placed in any point of it would indicate. Let us point out the principal facts which led M. Fourier to discover the existence of this heat peculiar

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* Mr. Jefferson speaking of Virginia, says, " A change in our climate is taking place very sensibly. Both heats and colds are become much more moderate, within the memory even of the middle aged. Snows are less frequent and less deep. They do not often lie, below the mountains, more than one, two, or three days, and very rarely a week. They are remembered to have been formerly frequent, deep, and of long continuance. The elderly inform me the earth used to be covered with snow about three months in every year. The rivers which then seldom failed to freeze over in the course of the winter, scarcely ever do so now." —T.

to the planetary spaces, independent of the primitive heat which the globe has preserved.

"In order to acquire the knowledge of this singular phenomenon, it is requisite to examine what would be the thermometrical state of the terrestrial mass, if it received heat only from the sun; and in order to make this examination easier, we will first suppose the atmosphere to be destroyed. Now, if no cause exists adapted to give a common and constant temperature to the planetary spaces—that is to say, if the terrestrial globe, and all the bodies which compose the solar system, were placed in an enclosure devoid of all heat, phenomena would be observed entirely contrary to those which we know to exist. The polar regions would endure an immeasurable cold, and the decrease in the temperature, from the equator to the poles would be incomparably more rapid and extensive.

"Upon the hypothesis of the absolute cold of space, if it is possible to conceive it at all, the effects of heat, such as we observe them on the surface of the globe, would be owing to the presence of the sun; the least variations of distance from that orb, would occasion very considerable changes of temperature in the earth; the intermission of days and nights would produce sudden and totally different effects from those which we perceive. The surface of bodies would instantaneously be exposed, at the commencement of night, to an infinitely intense cold; and animated bodies and vegetables would not be able to resist the equally strong and sudden action of a contrary description, which would take place upon the rising of the sun.

"The primitive heat preserve in the interior of the terrestrial mass, would not maintain the exterior temperature of space, nor prevent any of those effects which we have just described; for we know with certainty (as we have just seen) by theory and observation, that the effect of this central heat has long since become imperceptible at the superficies, although it may be very great at a middling depth.

"We conclude from these last remarks, and principally from the mathematical examination of the question, that there exists a physical cause always present, which moderates the temperatures at the surface of the terrestrial globe, and gives to this planet a fundamental heat, independent of the action of the sun, and its own heat which the interior mass has preserved. This fixed temperature, which the earth thus receives from space, differs little from that which would be indicated at the terrestrial poles. It is necessarily less than the temperature which belongs to the coldest countries; but in this comparison we must consider only well ascertained observations, and not take into account the accidental effects of a very intense cold, which might be caused by evaporation, violent winds, and an unusual expansio of the air.*

" After having ascertained the existence of the fundamental temperature of space, without which the effects of the heat observed on the superficies of the globe would be inexplicable, we shall add, that the origin of this phenomenon, if we may so speak, is evident. It is owing to the irradiation of all the bodies of the universe, whose light and heat can reach us. The stars which we perceive with the naked eye, the innumerable multitude of stars seen with the telescope, and of obscure bodies which fill the universe, the atmospheres which surround these luminous bodies, the rarified matters spread in different parts of space, concur in forming those rays which on all sides penetrate the planetary regions. We cannot conceive the existence of such a system of luminous, or heated bodies without admitting that every point of the space which contains them, acquires a settled temperature.

" The immense number of the celestial bodies compensates for the inequalities of their temperature, and renders the irradiation sensibly uniform.

" This temperature of space is not the same in the different regions of the universe, but it does not vary in those in which the planetary bodies are contained, because the dimensions of this space are without comparison smaller than the distances which separate them from the shining bodies. Thus in all points of the earth's orbit, this planet is subject to the same temperature of the heavens.

" It is the same with the other planets of our system : they all partake of the common temperature, which is more or less augmented for each of them by the impression of the rays of the sun, according to the distance of the planet from that orb."

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* This is the way in which we must explain the account given by Captain Parry, who speaks of having observed a degree of cold of 50° at Melville Island.

General Report of the Council of Public Instruction of Bengal, for 1841 *and* 1842.

The number of district schools under the Council of Education appear to be about 100, the number of scholars provided for, 14,782, or 147 to each school; but the average attendance is only 5019, or 50 to each school, and the expenditure being Co's. Rs. 6,15,529 per annum, is exactly Co's. Rs. 122 : 10 : 2 per head, which is about £12 : 10, English money, for each boy; rather more we should suppose than the average rates of day schools at home.* The course of education consists of English Reading, together with either Hindee, Bengalee, Persian, or Sanscrit Grammar. The boys, (for the system does not extend to the education of females,) are divided into several classes, the senior of which embraces probably about ten per cent. of the whole, and their reading extends to Elementary Geometry, selections from Homer's Iliad, Milton, Bacon, Locke, and select Essays on popular scientific subjects, published by the Society for the Diffusion of Useful Knowledge. Some portion of the press in noticing this Report, seemed to consider the means at the disposal of the Committee too limited; for our own part, we think them much too large, and that they ought to be reduced in proportion to the number of scholars actually attending the schools, as compared with the number enrolled, and who although provided for, decline to attend. The four lacs of rupees thus annually saved, we would devote to the examination and illustration of the natural productions of the country, a subject with which we have no reason to suppose any of the persons connected with the present system of Education are at all, even theoretically, acquainted. We would employ for this purpose, men, such as Messrs. Murchison, MacLeay, Swainson, Brown and Herschel, with the pay of Members and Presidents of the Law Commission, together with as many deputies as might be necessary. In the course of twenty years, the children of

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* As an instance of what children may be educated for in India, we would refer to the Catholic Orphanage, established by the Right Rev. Dr. Carew.—Ed.

India would then have something substantial to learn with regard to their own country; and under competent teachers, might then be made to comprehend even Homer and Milton, as well as the use and application of Bacon and Locke's Essays. As it is, we look upon the system of the Indian Educational Council as a baseless fabric, and the mere reading of Homer, Bacon, &c., a poor object of instruction.

Agri-Horticultural Society's Journal, and India Review.

When censuring in our last number, (page 460,) the editorial mistakes of our contemporaries, arising from the indiscriminate publication of scraps of private letters and memoranda, we regret to find that we unintentionally appear to direct our observations to other parties, than the conductors of the Journals to which we referred.

Our allusion in a note to the introduction of the Deodar, was only intended to illustrate the carelessness of the editors in publishing, without explanation, the short memoranda of distinguished writers, which are liable if unexplained, to be misunderstood. The introduction of the Deodar into Great Britain is a service which may, or may not, be due equally to Drs. Royle and Falconer, and the allusion to Dr. Royle *only,* in Colonel Sykes's memorandum, we believe to be from inadvertence; but it would be absurd to suppose that either Colonel Sykes or Dr. Royle, would wish to deprive Dr. Falconer of any portion of credit that might attach to him from this, or any other improvement. The zeal of Dr. Royle, his example, and success in directing the attention of the European public to the interest and value of the natural products of India, is entitled to our highest respect: to say nothing of the talents with which he has himself prosecuted the study of every branch of Natural History during a long residence in this country, and we should be sorry, if from any inadvertent expression on our part, we should appear for a moment to think otherwise.

Indian Coal.

We called the attention of Mr. Lyell, the distinguished Geologist, to this subject about two years ago in a letter, an extract from which we now beg to submit to our readers.

Extract of a letter from the Editor of the Calcutta Journal of Natural History to Charles Lyell, Esq. F.R.S., *dated 10th February*, 1841.

"You are aware from the reports of the Coal Committee, that the attention of the Indian Government has been directed to the best way of bringing the Indian Coal beds into use.

"In order to give such operations in India good effect, and to direct the attention of future Governments more especially to the subject, lest it be abandoned on the departure of the Earl of Auckland, the influential opinions of men of science in England would be highly useful.

"For my own part, I consider any thing short of a thorough investigation of the Indian coal formations, by persons of the very highest qualification for such enquiries, as time and money thrown away.

"There is a feeling here, as almost every where, that it is miners alone that are necessary for the practical development of coal districts.

"If this has proved to be an erroneous opinion in England, where coal mines have constituted one of the principal internal resources of the country for a period of at least 300 years, how much more so must it be here, where the country, and even the use of coal, is so little known?

"The places in which coal occurs in India are usually remote and unfrequented, and are scarcely even to be found on our best maps. The consequence is, that a person incapable of availing himself of the light which the study of organic characters of rocks has cast upon all such investigations, finds himself lost, literally, in a wilderness from which he is only anxious to withdraw as soon as possible. Perhaps he possesses himself of a few specimens of coal without attempting to make himself acquainted with the topography of the place; and without the power of communicating to others any distinct idea of the characters of the rocks, or the extent of the beds, he is satisfied to return, and quit the field just at a time when the researches of a qualified person should commence.*

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* Or as it sometimes happens, recommends practical operations to commence on wrong data, as in the instance of Tenasserim coal, where 50,000 Rs. at least were thrown away in working a wrong bed.—Ed.

"Thus the practical man, as he is called, seldom accomplishes any one object in deputations of this nature, while his failure consigns the district he has visited to unmerited neglect for another indefinite period.* In the mean time the Government continue to pay exorbitant rates for coal, the whole supplies of which are derived from a single district which remains in the hands of a few, whose interests are of course opposed to every thing calculated to interfere with their profits.

"Much may be in time expected from the liberal policy of the Government, but I doubt if any thing is likely to be accomplished within a reasonable period of time, except a system of operations on a greater scale be resorted to for the investigation of the coal formations of India, than any Government is likely to adopt, except at the suggestion of the highest scientific authorities.

"Perhaps, if you were to consult with Sir John Herschel and Mr. Murchison, something might be done; at all events your opinion could not fail to have great weight with the Court of Directors.†

"Suppose a geologist, with a distinguished assistant competent to succeed him, was to be assigned the investigation of the Assam and the Sylhet coal districts; the indications of coal along the Malay coast from Arracan to the 10th degree of latitude to a second; Cuttack district to a third; Palamow to a fourth; Rajmehal and the Nerbudda to a fifth; a sixth sent to Port Natal in South Africa, where coal has recently been brought to notice, and offered by the Portuguese authorities to the British Government.‡ In five years the whole investigation might be completed in a manner calculated to confer the highest service on science, as well as on the resources of the nation at large."

In reply to the above, Mr. Murchison, in a letter dated 16, Belgrave Square, 22d September 1842, states, that our letter to Mr. Lyell had only reached him a few days before,

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* An instance of this kind has occurred to Arrakan since the above letter was written; an officer appointed to examine the indications of coal along that Coast, for a distance of 200 miles, ascribes them all to a single *vein* of coal of no value, a phenomenon quite opposed to the details he has himself furnished.—Ed.

† We have only as yet heard from Mr. Murchison in reply to this reference.

‡ The recent discoveries of coal in the Straits, should render this quarter a seventh field of enquiry, while the South Sea Islands, where Coal is found at several points, would also require a separate enquiry. We are much mistaken if the interests of steam navigation will not soon demand some such liberal measure on the part of the British Government.—Ed.

and remarks, that whenever his thoughts have turned to our empire in the East, he has been surprized at the apathy which has prevailed relative to the coal deposits in and around India, and that no geologist has been engaged, regularly and systematically, to work out the relations of the rock masses, containing various mineral substances useful to man. The same distinguished authority also refers to the invitation he himself received when President of the Geological Society of London, from the Emperor of Russia, under whose immediate auspices he has been recently employed in geological enquiries in Russia, with special reference to the coal tracts of that empire; while, on the other hand, he remarks, in regard to British India, no information whatever has been sought for, and none of course has been tendered, although sooner or later, Mr. Murchison states, our Indian Government must subscribe to the necessity of employing well-instructed geologists, and alludes to the employment of Sir H. De la Beche, on the Ordnance Survey of England, as an acknowledgment of the principle.

But as the words of Mr. Murchison, as the President of the Geological Section of the British Association, as well as of the Geological Society of London, may have more weight than our own remarks, we here beg leave to quote them.

"I have for a long time been thinking with surprize (whenever my thoughts have been turned to that region, of the apparent apathy with which the subject referred to in your letter, 10th February 1841, to the address of Mr. Lyell, has been treated by those who govern India. I am happy to find by your letter, that more has been done than I supposed; still it is a marvellous and lamentable fact, that whilst very large sums have been spent upon enquiries into the botanical productions of Hindustan, and eminent botanists have been liberally employed, (to see which, no one can rejoice more than myself,) no geologist has been engaged, regularly and systematically, to work out the relations of the rock masses, containing various mineral substances useful to man.

" No great country save England has been without geologists employed by the State during the last ten or fifteen years, and in the appointment of Mr., now Sir H. De la Beche, to the office of geologist of the Ordnance Survey, the English Government has at length recognised the principle. In our own country, however, the great enterprise, and spirit of the Geological Society have worked out the leading data for which foreign governments, even the United States, are glad to pay. It seems singular too that the President of the Geological Society of London, should be invited to Russia, and should, under the auspices of the Emperor, have prepared a geological map of that region (with special reference to coal tracts) whilst in regard to British India no information whatever has been sought at our hands by your rulers, and no advice of course has been tendered. You have evidently taken the right course, which is, to bring public opinion to act upon our Indian Government, which sooner or later must subscribe to the necessity of employing well informed geologists under a skilful chief. The points to which you direct attention in search of coal seem to be judiciously selected, as far as I am competent to judge; and assuring you that I will at all times afford you any support in my power in prosecuting the praiseworthy, and truly national objects, &c."

(Signed) R. J. Murchison.

Upon this we would merely remark, that whatever be the character of the British Government in India in other respects, the world will estimate its policy in regard to these things, according to the opinion of Mr. Murchison. Although not yet in possession of the sentiments of Sir J. Herschel and Mr. Lyell on this subject, we hope to be so before long, when we shall not withhold them from our readers.

Collections.

We are indebted to R. W. G. Frith, Esq. for a fine young buck of *Cervus Elaphoides,* Hodgs, about three years old, for transmission to collections in England, as well as for a very healthy *Baloo-Soor,* and three specimens of *Ciconia Lucocephala,* Gm.

The latter soon became acquainted with the garden to which they were first introduced on their arrival in Calcutta, and always returned to it at sunset from the various ponds about the neighbourhood, which they visited during the day. Their singular appearance in Calcutta attracted attention, and being perfectly tame they were soon exposed to injuries; one had its wing broken by a dog, another was killed by some mischievous person, and the third, since these accidents befel its companions refuses to fly, and remains constantly with the wounded bird. The *Benturong* alluded to page 410, has also been kindly placed at our disposal by Mr. Delanougerede: it is perfectly tame and in good health. We are only awaiting favourable opportunity of transmitting these animals to England. We have also to acknowledge the kindness of Edward O'Riley Esq., of Moulmein, in forwarding, and that of Capt. R. S. Ross, of the steamer Hoogly, in taking charge of two civit cats for us. These unfortunately both died on board the steamer in coming from Moulmein, it is supposed, from having been both confined in the same cage. Had they reached us safe, they would have proved an interesting addition to the other animals which we hope shortly to be able to forward to England, for the Zoological Society's collection, or that of its President, the Earl of Derby.

We have also the pleasure to state, that Capt. Gordon, Political Agent at Moneypore, (whom we took the liberty of addressing on the subject,) has kindly undertaken to procure for the scientific world, live specimens of *Cervus frontalis,* described at p. 401, and figured Pl. XIII and XIV of the present volume. Capt. Gordon remarks, the species is most abundant in Moneypore valley ; that the rainy season, which is the time of breeding, will be the most favourable for obtaining young specimens, when as many of them as can be kept alive he has kindly promised to send down to Calcutta next winter. We have sent skeletons and skins of this species to the Garden of Plants, Paris ; as well to the collection at the India House, on the part of Capt. Guthrie, to whom we have been indebted for these specimens.

Errata to the Analysis of Sugar Cane, No. 12.

Page 507, last line, *for* acrometer *read* " areometer."
" 508, line 13, *delete* the word " red."
" 508, " 28, the comma after " alkaline."
" 509, " 4, from bottom *for* " The leaves," *read* " The canes."
" 510, " 13, *for* " Ligneous matter 36.3" *read* " 35.3."
" 511, " 14, after " salts," substitute a semicolon for the comma.
" 512, " 20, *for* " causes" *read* " means."
" " line last, *for* " he writes, if a Planter who makes conveniently," *read* " he writes, " a Planter who makes annually."
" 519, line 2, *after* " limit" *add* a semicolon. In line 3, *dele* the period after " rollers." In line 20 *add* a comma after " results," and " that." In line 28, *for* " Pharmacie," *read* " Pharmaciest."
" 514, line 19, *for* " of the Arundo sacharifera as sugared matter," *read* " of the Arundo sacharifera a sugared water." In line 23, *for* " macie," *read* " macist." In line 29, *for* " as in the Coasts," *read* " as on the Coast." In line 31, *for* " of the juice by rapidly evaporating," *read* " if the juice be rapidly evaporated." In the last, line *for* " various," *read* " viscious."
" 515, line 16, *for* " connects," *read* " converts." In line 22 for " meeting," read " swelling." In line 26, *for* " Arsenical," *read* " Animal."
" 516, line 2, *for* " tubercules," *read* " tubercles."

Errata in Faraday's Experimental Researches, No. 9.

Page 4, last line, *for* " water" *read* " matter."
" 17, line 6, from top, *for* " electricited," *read* " electric."
" 19, line 8, from top, *for* " ventrality," *read* " neutrality."

Meteorological Register kept at the Surveyor General's Office Calcutta, for the Month of October, 1842.

The Observations after Sunset are made at the Hon'ble Company's Dispensary.

October. Days of the Month.	Moon's Changes.	Observed at 9 H. 50 M.						Observed at 4 P. M.				Rain Gauges.		Observations made at 8 P. M.					Observations made at 10 P. M.		
			Temperature.			Wind.		Temperature.			Wind.				Temperature.				Temperature.		
		Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of the Evapg. Surface.
		Inches	°	°	°		Inches	°	°	°		Inches	Inches	Inches	°	°	°	Inches	°	°	°
1		29,681	83,9	86,5	82,0	N. E.	29,600	87,4	88,7	83,2	E.	1,34	1,37	29,825	84,75	85,25	84,25	29,825	84,36	85,25	84,25
2		,650	79,8	78,0	76,0	(high) N. E.	,589	81,0	79,1	77,0	(high) E.	1,54	0,59	,775	82,0	81,5	80,5	,750	81,75	81,0	80,0
3	●	,674	84,1	87,0	82,0	S E.	,634	84,7	86,0	81,0	S.	0,05	0,08	,886	83,25	84,0	83,75	,850	83,0	83,1	81,0
4		,722	84,6	86,6	82,1	S	,653	86,0	88,0	82,5	S.			,900	85,0	84,0	83,75	,900	84,25	83,25	82,2
5		,690	84,0	85,0	81,0	S	,605	86,0	88,0	83,0	S.	0,22	0,27	,796	85,0	84,25	84,0	,813	84,25	84,0	83,25
6		,638	82,0	83,0	79,8	S E.	,577	84,1	85,2	81,8	S.	0,25	0,31	,750	83,0	83,5	81,5	,755	8,35	83,2	81,0
7		,713	83,4	85,0	79,0	N. W.....	,665	85,2	88,5	81,7	W. S. W.			,900	84,25	84,0	83,5	,866	84,0	84,0	83,5
8		,700	83,8	87,5	80,8	W.	,646	85,7	89,0	81,4	W.			,850	85,5	85,0	84,75	,875	85,5	84,75	84,5
9		,753	84,0	88,0	81,0	S. W. ...	,680	87,0	90,0	82,0	S.	0,32	0,41	8,30	84,0	85,0	83,0	,890	83,0	84,5	82,5
10		,838	83,2	86,0	81,8	S.........	,793	84,5	88,0	82,1	S. W....			30,100	84,0	83,75	83,25	30,100	84,0	83,5	83,0
11	☽	”	”	”	”	”	”	”	”	”	”			,112	83,5	83,25	82,75	,150	83,25	83,0	82,5
12		”	”	”	”	”	”	”	”	”	”	0,53	0,65	,100	82,0	82,0	80,25	,100	81,5	81,5	80,0
13		,906	81,5	82,0	78,2	N. E	,833	78,5	77,0	73,9	E.			,100	84,0	85,0	84,0	,100	84,0	84,5	84,0
14		,898	80,2	82,0	77,5	N. E	,806	83,0	86,0	80,0	N. E.....			,050	80,0	80,0	74,0	,100	80,0	80,0	74,0
15		,881	80,8	80,0	76,5	N.	,786	82,5	86,0	80,2	S.			,000	81,5	81,25	81,0	,050	81,0	81,0	79,5
16		,996	81,9	83,7	78,7	S. E.	,810	81,9	83,8	79,0	W. S. W.			,100	85,0	84,75	83,0	,100	85,0	84,5	83,0
17		,874	79,3	80,7	76,8	N. E. ...	,806	82,8	85,0	79,2	N.			,000	81,5	81,25	80,0	,000	81,25	81,0	80,0
18	○	,866	80,8	83,1	78,5	N. E.	,790	82,5	85,5	79,0	N.			,000	80,0	80,0	79,0	,000	80,0	80,0	79,0
19		,877	82,0	86,0	80,0	N. E.	,814	83,0	87,0	80,2	N. W....			,100	84,0	83,5	84,0	,100	83,75	83,5	83,5
20		,874	82,3	85,0	79,0	N.	,800	83,4	85,5	80,8	N.			,050	83,5	82,75	82,5	,050	83,0	82,5	82,25
21		,877	83,0	87,0	81,0	N. E.	,817	84,5	88,6	81,7	N.			,150	83,5	82,75	82,0	,150	83,6	83,6	82,0
22		,873	82,8	87,0	81,5	E.	,802	85,6	88,0	81,0	N.			,000	84,0	83,5	82,75	,000	84,0	83,5	82,75
23		,881	83,2	86,0	79,8	N. E.	,800	85,2	88,0	80,0	N.			,000	83,0	82,75	82,25	,050	82,25	82,0	81,5
24		,913	82,6	85,2	78,5	E.........	,853	85,8	88,3	80,0	N. E.....			,158	82,5	82,5	80,75	,158	82,0	82,0	81,0
25		,914	82,0	85,5	78,0	N. E.	,842	85,2	88,4	80,0	N.			,050	83,0	82,5	82,0	,050	83,0	82,25	82,0
26	☾	,877	82,1	84,5	78,2	N. W.....	,794	84,8	88,0	81,0	N. E.	0,06	0,12	,000	83,0	82,75	8,25	,050	83,0	82,5	81,5
27		,854	80,5	80,5	76,0	N.	,798	81,5	82,6	76,0	W. S. W.			,055	80,0	80,2	7,95	,055	79,5	80,0	79,0
28		,877	79,8	80,3	76.0	S..........	,798	83,9	86,0	79,0	S. W.....	0,11	0,16	,000	82,0	81,5	81,0	,000	82,0	81,0	81,0
29		,870	82,0	84,5	78,0	W. S. W.	,782	83,9	88,0	79,0	W. S. W.			,000	83,0	827,5	82,0	,050	82,0	81,75	81,0
30		,874	81,0	82,0	78,0	N. W. ..	.806	83,0	84,5	78,1	W. S. W.			,029	81,5	81,5	80,0	,075	81,2	81,5	80,0
31		,857	80,2	82,0	78,0	W.	,781	82,8	88,0	81,0	W.			,000	81,5	81,0	8,10	”	”	”	”
Mean.		29,821	82,1	84,1	79,1		29,750	83,9	86,4	80,2		3,42	3,96								

N. B. From a comparison of the two Barometers, the Mercury in that at the Dispensary stands 1-10th of an inch higher than that in use at the Surveyor General's Office.

Meteorological Register kept at the Surveyor General's Office, Calcutta, for the Month of November 1842.

The Observations after Sunset are made at the Hon'ble Company's Dispensary.

November. Days of the Month.	Moon's Changes.	Observed at 9 H. 50 M.					Observed at 4 P. M.					Rain. Gauges.		Observations made at 8 P. M.				Observations made at 10 P. M.			
			Temperature.			Wind.		Temperature.			Wind.				Temperature.				Temperature.		
		Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.
		Inches	°	°	°		Inches	°	°	°		Inches	Inches	Inches	°	°	°	Inches	°	°	°
1		29,889	80,8	81,7	78,0	S.	29,818	82,4	88,5	81,2	N. W.				81,25	81,25	80,0		81,1	81,1	80,0
2	●	,861	81,0	84,0	77,0	W.	,810	83,0	86,0	79,3	N.				81,5	81,5	8,00		81,0	81,0	79,5
3		,873	80,5	83,8	74,6	N. E.	,818	81,0	84,0	74,0	N.			30,000	80,0	79,5	77,5	30,000	80,0	79,25	77,5
4		,903	78,5	81,0	72,8	N.	,829	79,5	82,0	71,4	N.			,050	78,7	77,5	75,5	,055	77,25	77,0	75,25
5		,881	76,5	78,0	70,6	N.	,822	78,0	80,0	71,8	N.			,086	76,5	76,5	75,0	,089	75,8	75,8	74,0
6		,869	76,2	78,4	71,0	N.	,805	78,5	82,5	73,0	N.			,044	76,5	76,5	75,75	,044	76,5	76,5	75,75
7		,862	76,0	79,0	72,8	N.	,805	78,0	82,8	72,1	N. W.			,050	77,25	76,25	75,0	,050	77,0	76,0	74,75
8		,862	76,3	79,0	71,9	N.	,807	79,0	83,0	74,0	N.			,090	77,0	76,0	74,25	,100	76,0	76,2	74,0
9		,857	77,0	81,2	73,0	N.	,805	80,8	83,8	75,9	N. W.			,090	77,0	76,0	74,5	,090	77,25	76,0	74,5
10	☽	,854	77,2	82,0	76,0	N. E.	,790	80,5	86,0	77,0	E.			,000	78,75	78,25	77,5	,000	88,0	87,75	87,0
11		,865	78,5	82,0	76,1	N. E.	,800	80,4	83,2	76,5	N. W.	0,14	0,19	,060	78,5	78,5	76,75	,100	77,4	77,4	75,5
12		,894	78,0	81,0	74,7	N. E.	,826	79,2	84,0	76,8	N.			,060	78,5	78,0	77,0	,060	78,5	78,25	77,25
13		,893	77,0	81,5	74,3	N. E.	,830	79,0	84,0	75,0	N. W.			,000	78,0	77,75	77,0	,000	77,5	77,0	76,25
14		,946	77,8	81,9	74,0	E.	,877	79,5	84,0	75,0	N. W.			,125	77,8	78,8	77,0	,200	77,5	77,5	75,75
15		,970	76,8	78,2	72,0	N. W.	,880	78,0	84,0	76,0	W.			,100	77,0	77,0	76,5	,,	,,	,,	,,
16		,965	77,0	81,0	74,3	S. W.	,885	79,3	84,0	76,2	N. W.			,100	77,0	76,75	75,75	,100	76,25	76,0	75,0
17		,973	77,0	79,6	72,2	W.	,882	79,2	84,0	75,0	N. W.			,100	76,8	76,8	75,0	,129	76,0	76,0	74,25
18	○	,922	76,0	78,8	72,0	N. W.	,846	79,0	82,4	73,0	N.			,100	77,0	76,75	75,0	,100	77,0	76,5	75,0
19		,965	76,8	80,2	72,8	E.	,869	79,0	82,2	72,0	N.			,100	76,25	76,0	75,0	,,	,,	,,	,,
20		,953	76,0	79,0	71,3	N. E.	,869	78,2	81,0	71,0	N.			,100	74,8	74,8	73,0	,100	74,0	74,0	72,25
21		,954	74,5	77,0	70,0	N.	,875	76,6	80,0	71,0	N.			,100	74,0	74,0	73,0	,100	74,0	73,0	71,0
22		,966	73,2	75,0	68,0	N.	,866	76,6	80,2	72,2	N.			,085	74,2	74,2	72,5	,100	73,5	73,5	71,75
23		,938	73,4	77,5	70,8	N. W.	,845	77,4	80,8	73,4	N. W.			,090	74,25	74,25	72,25	,105	73,75	73,75	71,75
24		,926	74,6	78,3	71,2	N. E.	,830	76,9	80,4	74,3	N.			,025	74,25	74,25	73,0	,025	74,0	74,0	73,0
25	☾	,885	74,5	77,8	71,0	N.	,825	77,0	80,8	73,2	N.			,100	74,75	74,25	73,5	,100	74,5	74,0	73,0
26		,889	74,0	77,2	70,0	N.	,814	77,0	76,8	70,0	N.			,050	74,5	74,0	72,0	,050	73,0	73,75	71,5
27		,917	72,2	75,3	68,5	N. W.	,838	75,8	79,8	69,0	N. W.			,050	73,0	72,5	71,0	,050	73,0	72,25	71,0
28		,962	71,0	74,0	65,0	N. W.	,862	75,0	78,9	68,0	N. W.			,100	71,5	71,25	69,25	,100	71,0	70,75	69,0
29		,966	71,9	77,0	69,5	E.	,896	74,7	79,9	71,9	N. W.			,100	71,75	71,25	71,0	,100	71,25	71,0	70,0
30		,985	71,6	74,7	67,5	N. W.	,893	74,0	77,0	70,8	N. W.			,100	72,0	71,75	71,0	,,	,,	,,	,,
Mean.		29,915	76,1	79,2	72,1		29,841	78,4	82,5	73,7		0,14	0,19								

N B. From a comparison of the two Barometers, the Mercury in that at the Dispensary stands 1-10 of an inch higher than that in use at the Surveyor General's Office.

The Barometer Observations of the 1st & 2d have been rejected.

Meteorological Register kept at the Surveyor General's Office, Calcutta, for the Month of August 1842.

August. Day of the Month.	Moon's Changes.	Observed at 9 H. 50 M.					Observed at 4 P. M.					Rain Gauges.	
		Barometer.	Temperature.			Wind.	Barometer.	Temperature.			Wind.		
			Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.		Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.
		Inches	°	°	°		Inches	°	°	°		Inches	Inches
1		29,458	82,1	80,6	80,4	W. S. W. ..	29,409	82,1	81,0	81,0	W. S. W.	0,87	1,14
2		,515	80,2	79,2	79,0	S. W.	,478	85,1	85,9	83,0	S. W.	0,08	0,15
3		,542	82,8	84,0	81,3	W.	,493	83,0	80,0	80,0	S.	2,97	3,30
4		,570	82,0	83,2	81,0	S. W.	,525	85,0	86,2	83,6	S. W.	1,57	1,78
5		,565	82,4	82,0	82,0	S.	,521	86,2	88,0	84,6	S.		
6	●	,593	82,0	83,8	81,0	Calm.	,530	83,4	84,0	81,2	S. W.		
7		,573	83,5	85,4	82,9	S. W.	,489	85,2	87,2	82,8	S.		
8		,533	85,1	87,2	84,0	S.	,445	88,2	90,0	84,5	S.	2,56	2,96
9		,498	82,8	83,0	81,8	Calm.	,462	82,1	81,0	80,5	Calm.	0,61	0,73
10		,557	83,5	84,8	82,8	W.	,514	84,0	84,6	82,9	Calm.	0,27	0,34
11		,574	83,0	85,2	83,3	Calm.	,522	82,0	81,0	81,0	Calm.	0,11	0,16
12		,586	82,4	83,2	82,0	S. W.	,530	86,0	88,0	84,0	S. W.	0,67	0,87
13	☾	,610	83,5	85,2	83,5	S.	,549	86,5	88,5	85,0	S.		
14		,606	81,8	85,2	82,8	S. W.	,557	85,2	85,0	83,0	S.	1,16	1,36
15		,650	83,0	83,4	82,0	S.	,593	85,3	85,8	84,0	S.	4,05	4,75
16		,718	83,2	83,8	82,0	S.	,650	80,0	77,9	78,0	S.	1,46	1,57
17		,713	83,0	84,5	82,0	S.	,650	84,8	85,4	83,0	S.	0,05	0,09
18		,678	83,1	84,0	82,2	S.	,602	83,0	82,2	82,0	Calm.		
19		,654	82,5	85,3	83,0	S.	,561	84,1	87,0	84,0	S. E.	0,24	0,32
20		,637	83,2	85,0	82,7	E.	,563	83,8	84,6	82,8	S. E.	0,54	0,64
21	○	,633	84,2	87,8	84,9	N. E.	,578	84,4	85,0	83,0	E.	0,15	0,23
22		,622	83,8	84,2	81,9	S. E.	,557	86,3	87,8	82,8	S. E.	0,05	0,08
23		,600	83,8	86,5	82,6	S.	,538	85,8	88,2	86,0	S.	0,16	0,21
24		,576	83,5	86,5	84,0	W.	,494	85,5	88,0	85,0	E.		
25		,581	84,0	87,8	84,0	E.	,522	84,8	84,5	83,0	E-		
26		,600	84,9	87,2	84,0	E.	,537	83,8	84,0	82,0	E.	0,45	0,54
27		,573	85,1	87,2	84,0	E.	,473	87,0	86,0	85,0	E.	0,19	0,23
28		,525	84,0	86,0	83,0	E.	,458	81,2	80,0	80,5	E.	0,32	0,38
29	☽	,618	83,0	84,6	83,0	E.	,582	83,4	83,8	82,6	S. E.	0,08	0,13
30		,678	82,9	86,4	83,0	S. E.	,600	85,4	89,0	87,2	S. E.		
31		,635	86,0	88,5	86,0	E.	,550	86,0	88,4	83,8	E.		
Mean.		29,597	83,3	84,9	82,7		29,535	84,4	85,1	83,0		18,61	21,97

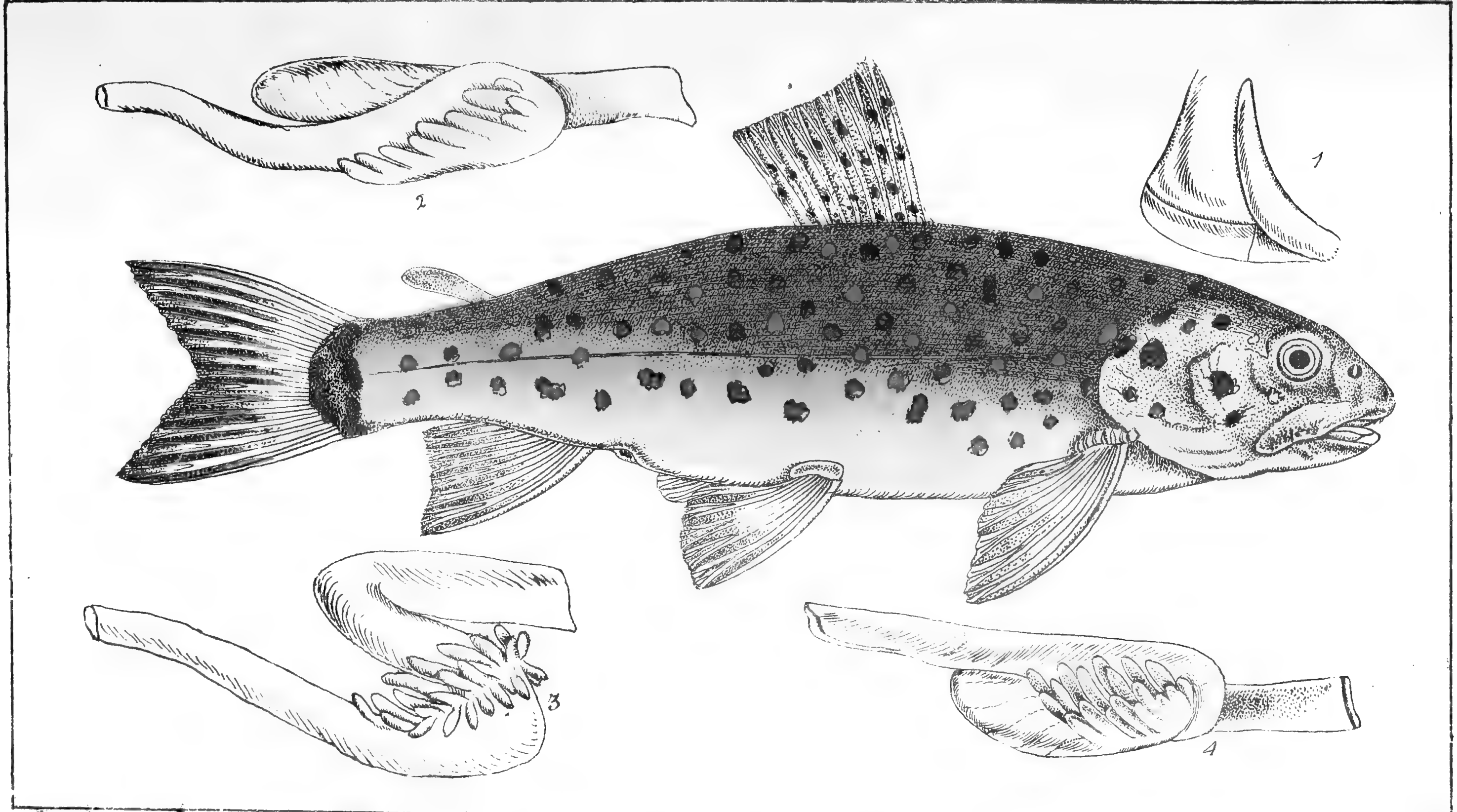
Meteorological Register kept at the Surveyor General's Office, Calcutta, for the Month of September 1842.

The Observations after Sunset are made at the Honorable Company's Dispensary.

September, Days of the Month.	Moon's Changes.	Observed at 9 H. 60 M.					Observed at 4 P. M.					Rain Gauges.		Observations, made at 8 P. M.				Observations made at 10 P. M.				Observations made at Midnight.			
			Temperature.			Wind.		Temperature.			Wind.				Temperature.				Temperature.				Temperature.		
		Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Direction.	Upper.	Lower.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.	Barometer.	Of the Mercury.	Of the Air.	Of an Evapg. Surface.
		Inches	°	°	°		Inches	°	°	°		Inches	Inches	Inches	°	°	°	Inches	°	°	°	Inches	°	°	°
1		29,650	84,4	86,0	84,0	E. ..	29,589	84,5	85,0	83,0	S.....	0,13	0,16	29,750	84,25	84,0	83,0	29,750	84,25	83,0	81,0				
2		,706	83,0	83,0	82,2	E. ..	,650	86,0	87,0	84,0	S.....			,850	85,0	84,12	83,36	,850	85,0	84,12	83,36				
3		,689	83,9	85,5	82,4	S. W.	,618	86,5	87,3	86,2	S.....	0,07	0,08	,850	85,0	85,0	84,12	,850	85,0	84,25	83,36				
4		,657	84,4	88,0	85,0	E. ..	,550	86,5	88,4	86,5	E. ..			,750	85,25	85,0	83,25	,750	85,25	85,0	83,25				
5	●	,589	85,9	88,5	86,4	N. E.	,485	89,8	92,0	89,0	N. E.	0,52	0,61	,700	85,25	85,0	82,25	,700	85,25	85,0	82,25				
6		,526	82,9	82,6	82,0	E. ..	,470	83,3	82,5	82,0	S. E.	0,67	0,77	,725	85,25	85,0	82,36	,750	77,25	82.25	80,0	29,700	85,25	83,25	82,25
7		,610	79,0	76,5	76,8	S. E.	,550	81,1	80,8	80,5	S. E.			,750	85,25	85,0	82,25	,725	85,25	85,0	82,25				
8		,646	82,0	82,1	82,0	S.....	,590	84,1	85,0	84,0	S.....			,800	84,0	83,25	83,0	,800	84,0	83,25	83,0				
9		,686	84,2	85,8	83,0	S.....	,594	85,9	86,5	84,0	S.....			,750	84,0	84,25	82,25	,750	83,25	84,0	82,0				
10		,658	85,8	87,8	85,0	S.....	,554	87,8	88,6	85,7	S.....	0,19	0,30	,775	84,25	84,0	82,36	,750	83,25	84,0	82,0				
11	☾	,595	84,8	85,9	83,8	S. W.	,521	86,3	87,0	84,8	S. W.			,725	86,25	86,0	85,25	,800	86,0	85,0	84,0				
12		,609	85,0	86,5	85,0	N. E.	,560	83,0	83,0	82,3	N. E.	0,41	0,46	,800	83,0	85,5	82,25	,810	83,0	83,0	81,25				
13		,658	83,4	85,7	83,8	E. ..	.594	83,6	84,0	83,0	E. ..	0,11	0,14	,850	83,25	83,0	82,25	,850	83,25	83,0	82,25				
14		,698	84,0	86,6	84,5	E. ..	,638	84,9	85,9	84,0	S. E.	0,08	0,11	,900	85,0	84,12	83,25	,900	84,36	84,0	83,16				
15		,782	84,0	86,9	84,0	S.....	,677	86,4	88,3	85,0	S. W.	0,06	0,08	,900	84,0	84,25	83,0	,900	85,0	84,25	83,12				
16		,762	84,0	86,6	84,0	S....	,686	87,8	89,0	84,0	s. s. w.			,900	86,0	85,36	85,0	,950	85,25	85,0	84,25	,900	84,0	84, 0	81,25
17		,769	85,0	88,0	84,2	S.....	,677	88,5	90,0	85,5	S. W.	0,17	0,22	,900	86,16	85,36	85,12	,925	86,0	85,12	84,36				
18		,782	84,8	87,0	84,0	S.....	,709	86,5	88,0	85,0	S. W.	0,06	0,09	,900	85,0	86,0	84,0	,950	85,0	85,25	82,25	,925	85,25	85, 0	84,12
19		,806	85,0	88,0	84,0	S.....	'709	87,8	91,0	86,0	w. s. w.			,950	86,25	85,25	85,0	,950	85,0	85,25	84,36				
20	○	,770	85,0	86,4	84,0	S. W	,673	86,2	87,0	85,0	S.....			,875	86,12	85,36	85,0	,825	86,12	85,25	85,0				
21		,717	85,0	87,1	84,0	s. s. w.	,638	87,4	88,5	85,0	S.....			,850	85,0	85,25	83,25	,850	85,0	84,20	82,36				
22		,685	85,0	87,0	83,0	S.....	,594	87,0	87,0	83,0	S.....			,750	85,25	85,0	84,0	,750	85,25	85,0	84,0	,850	84,25	84,12	84,12
23		,650	84,8	84,6	82,4	S. W.	,570	86,9	88,0	84,0	S.....			,875	87,0	86,12	85,25	,800	86,0	85,36	84,36				
24		,630	85,9	88,7	84,0	S. E.	,538	87,5	90,0	83,4	w. s. w.			,800	85,0	85,2	82,25	,800	85,0	85,0	82,0				
25		,645	85,5	90,0	84,8	E. ..	,565	88,0	90,0	85,1	E. ..	0,11	0,15	,800	86,0	85,0	84,36	,825	85,25	85,0	84,25				
26		,645	82,7	81,0	80 0	E. ..	,590	81,5	79,0	78,5	E. ..	0,24	0,27	,800	88,0	82,36	80,25	,800	83,0	82,36	81,0				
27	☽	,669	82,0	82,0	80,9	E. ..	,625	81,8	80,2	79,0	E. ..	0,27	0,34	,850	83,0	82,25	80,36	,850	82,0	82,0	80,0				
28		,774	84,1	84,0	81,0	S. F.	,703	82,8	82,0	80,2	N. ..	0,15	0,22	,950	84,12	83,12	83,0	,900	84,0	83,12	83,0				
29		,769	82,9	84,1	81,0	S. E.	,678	86,7	90,0	83,2	N W.			,850	85,25	85,0	84,25	,875	85,25	84,36	84,0				
30		,712	84,5	86,4	82,8	N. W.	,625	88,8	89,5	84,0	N. ..	0,05	0,08	,875	85,0	86,0	84,0	,875	85,0	85,36	84,12	,900	85, 0	84,25	84,25
31																									
Mean.		29,685	84,1	85,6	83,1		29,608	85,8	86,3	84,2		3,29	4,08												

N. B. From a comparison of the two Barometers, the Mercury in that at the Dispensary stands 1-10th of an inch higher than that in use at the Surveyor General's Office.

Index.



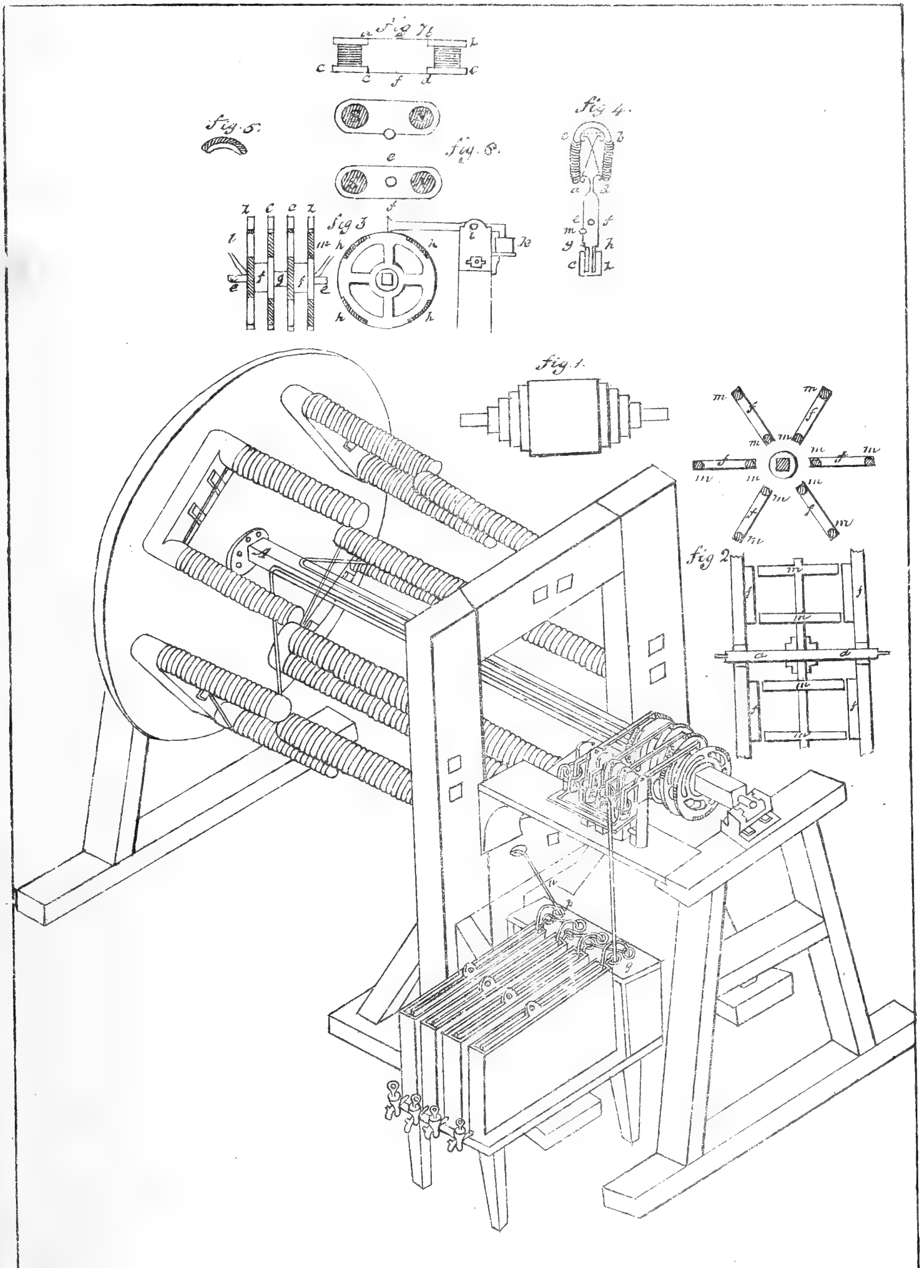
W. Griffith del

J. M. Lith

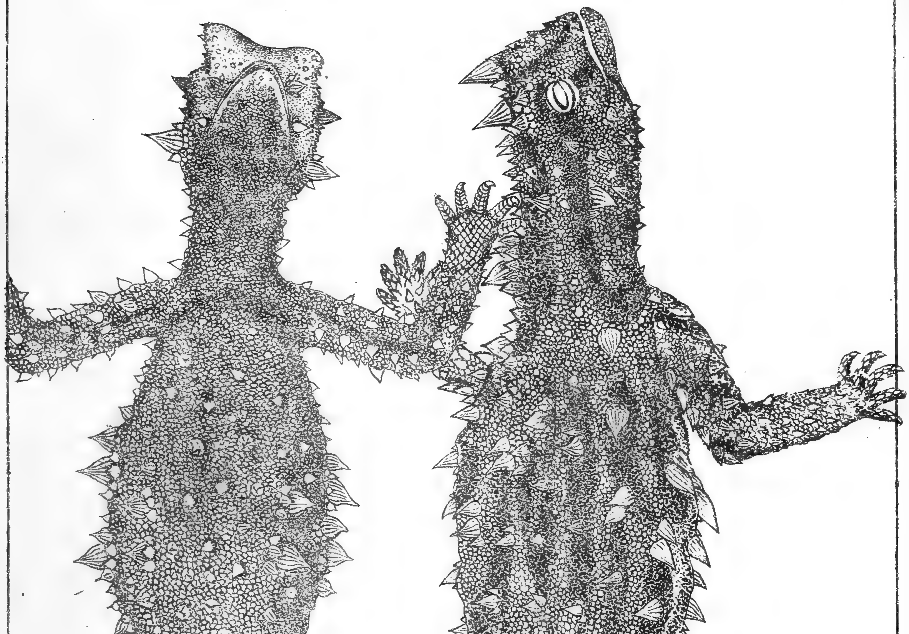
Salmo orientalis. Mcclell & Griff.

Reduced for Calcutta Journ: Nat Hist

Pl. IV



Pl. V



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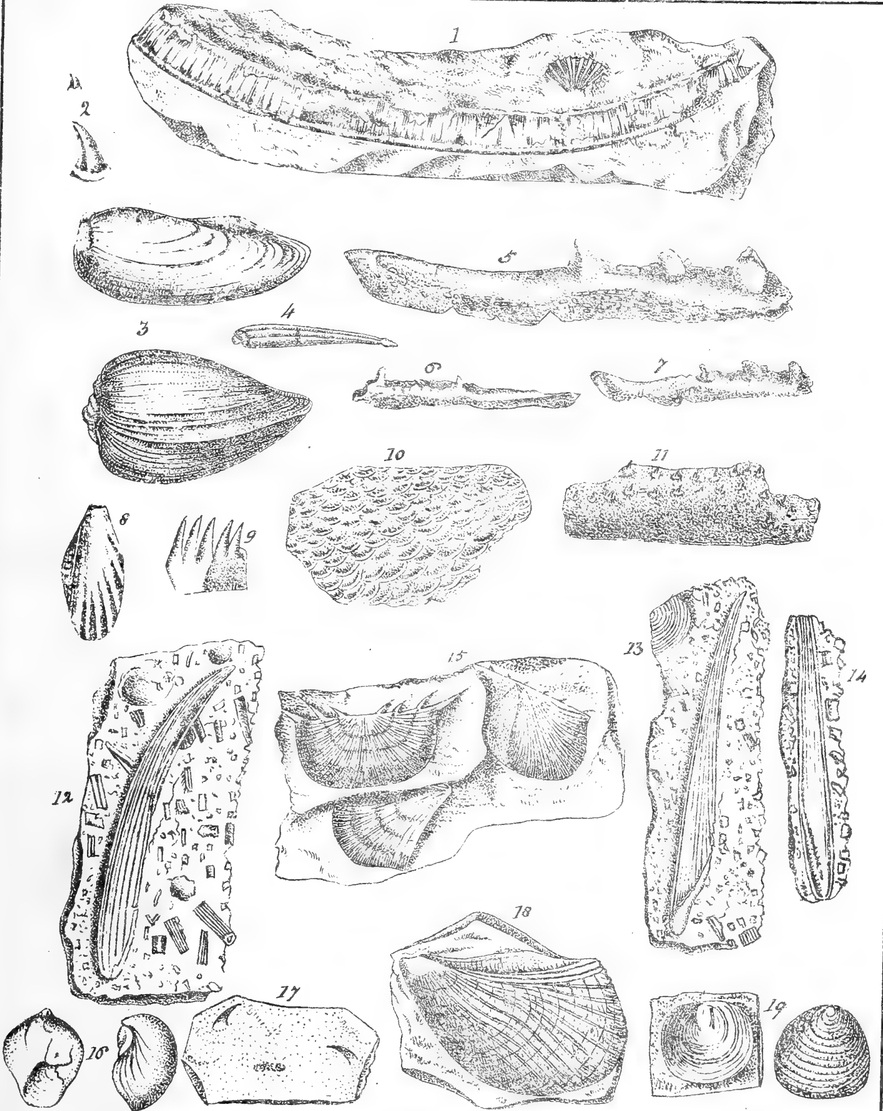
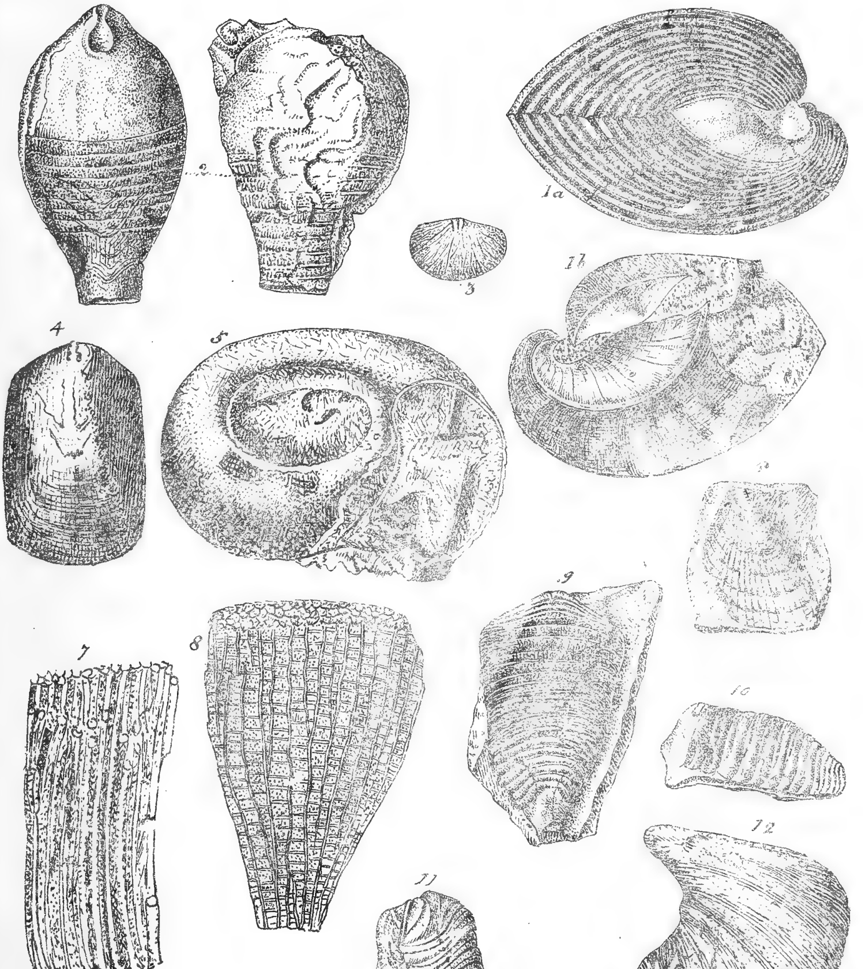


F. 1 serpulites tongissimus.
2 & 33 Teeth.
3 cypricardia amygdatina.
4 Onchus Murohisoni, (Ag.)
5. 6. 7. Plectrodus mirabilis (Ag.)

8. Shell.
9. Tooth of sphagodus pristodontus
10 mag^{d} Protions of pterygotus problematicus (J.y)
11 skin or shagreen of Sphagodus (Agass.)
12 - 13 - 14. Onchus tenuistriatus.
15 Leptæna lata. (V. Buch).
16 Terebratula Navicula.
17 Teeth
18 ___ lineata.
19. orbicula rugala.



1a Pentamerus Knightii (M.C.) 8b Sect. 8c young
2 ——— pyriforme
3 Leptoena Lepis (Dalm.)
4 Lingula Lewisii
5 Bellerophon Aymestriensis
6. ——— Avicula reticulata
7. 8. Favosites Gothlandica
9. 10 ——— Homalonotus Knightii
11 ——— Ludensis
12.13 ——— nautoleum

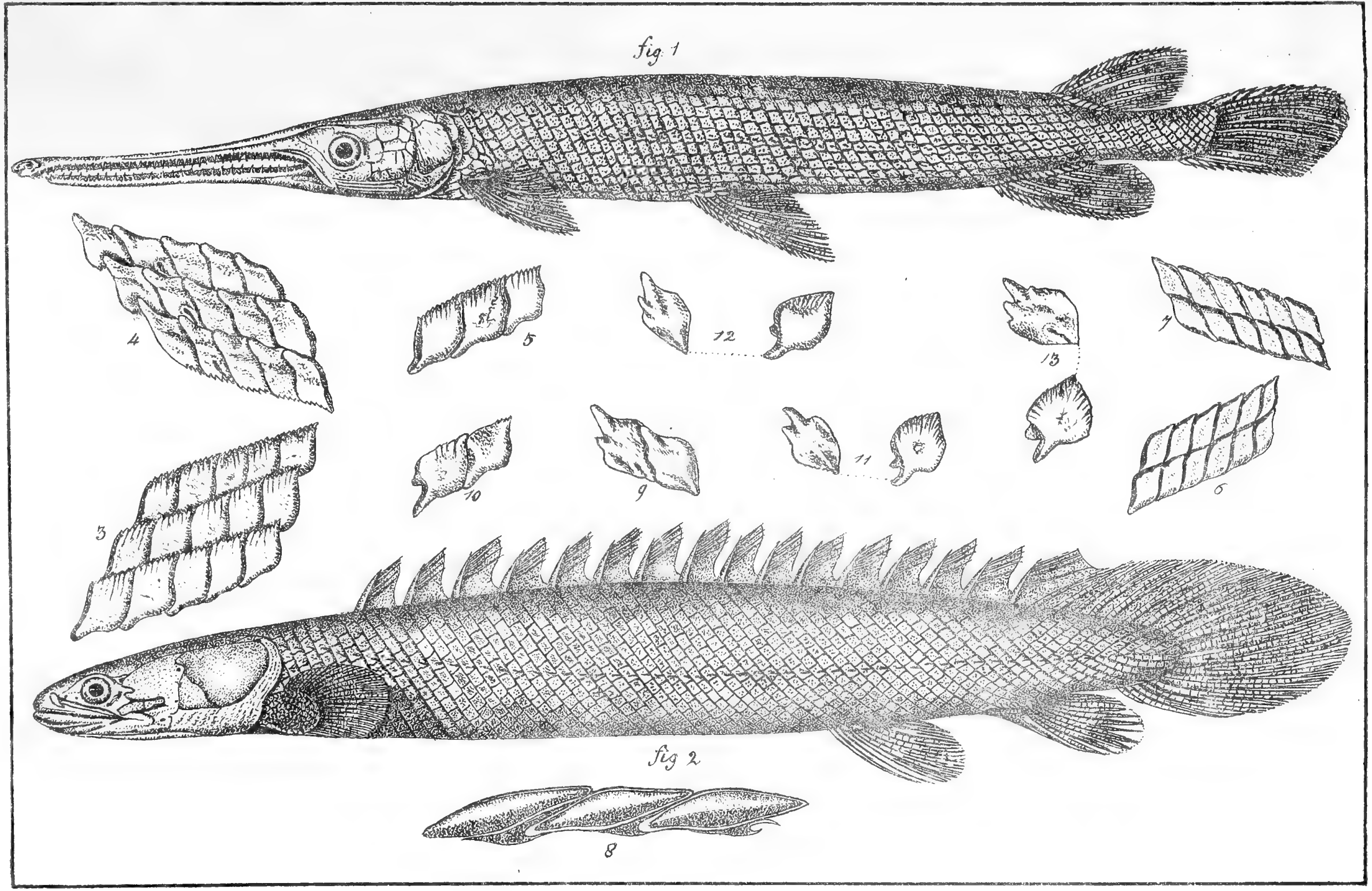


fig. 1
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fig 2
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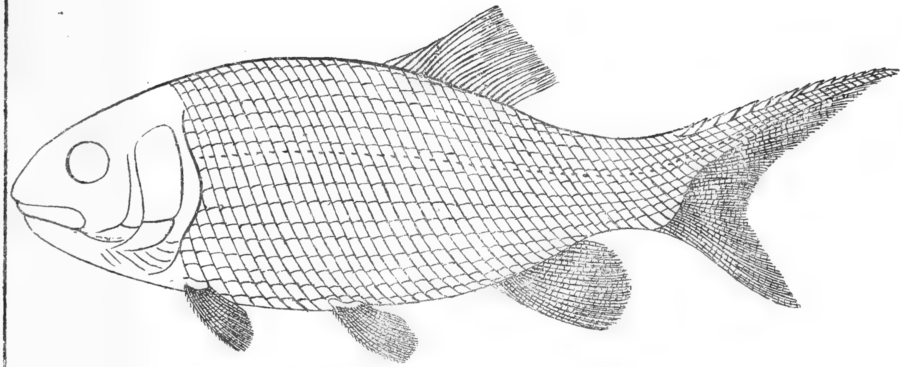


Fig. 1. PALAEONISCUS. Ag.

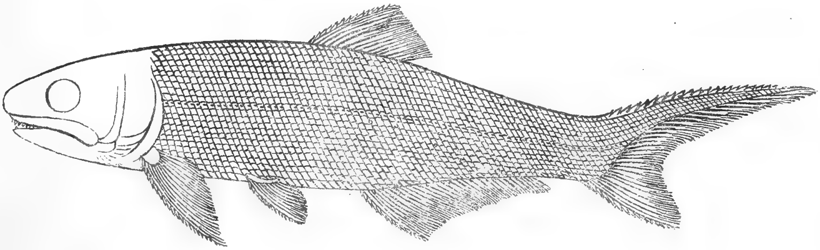


Fig 2 PYGOPTERUS. Ag.

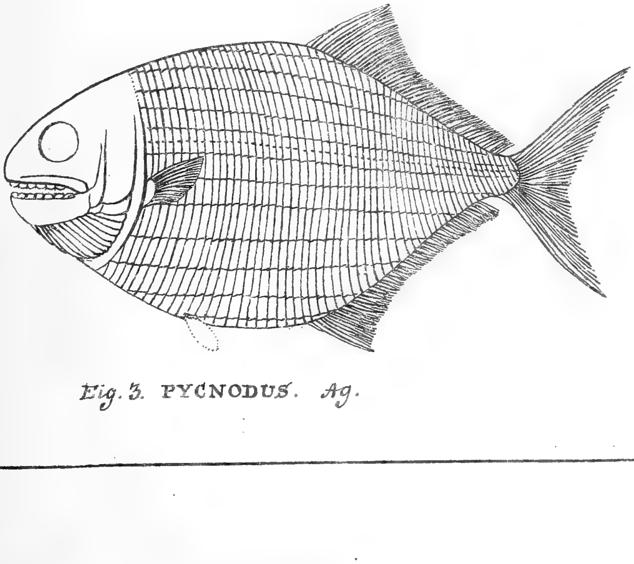
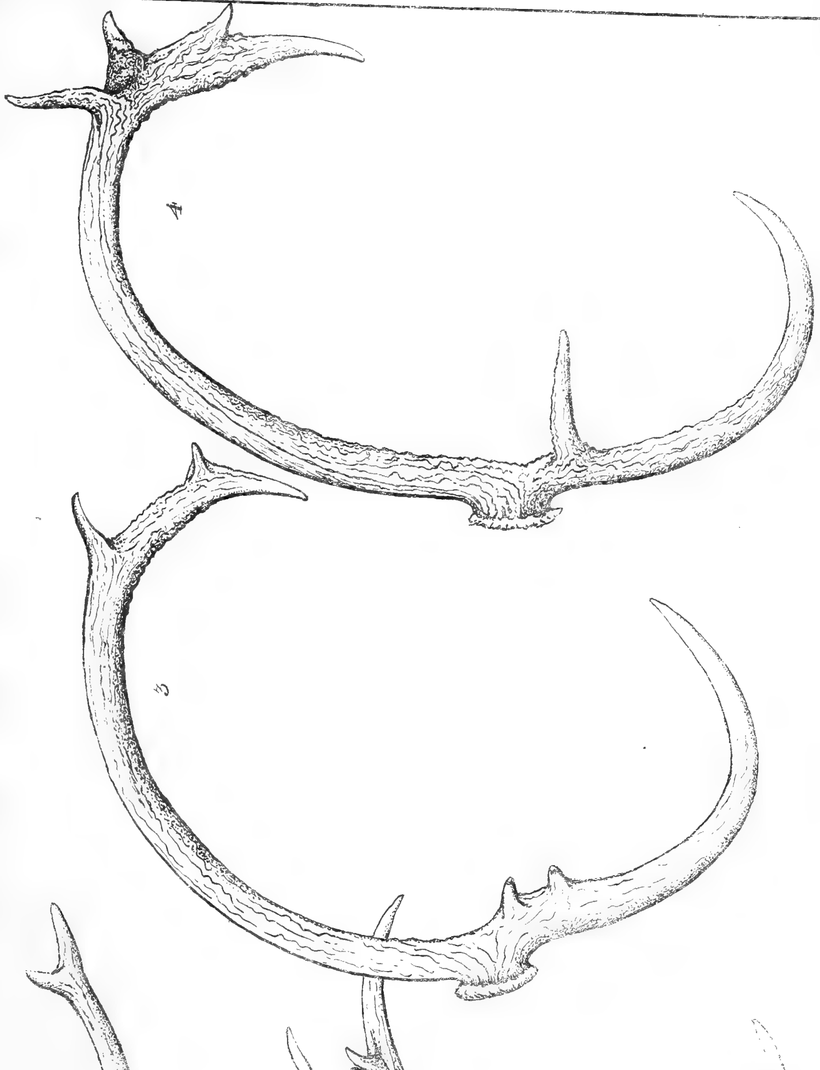


Fig. 3. PYCNODUS. Ag.

The Sungnai

Cervus (Rusa) frontalis. J. M.

W. M. westermann del.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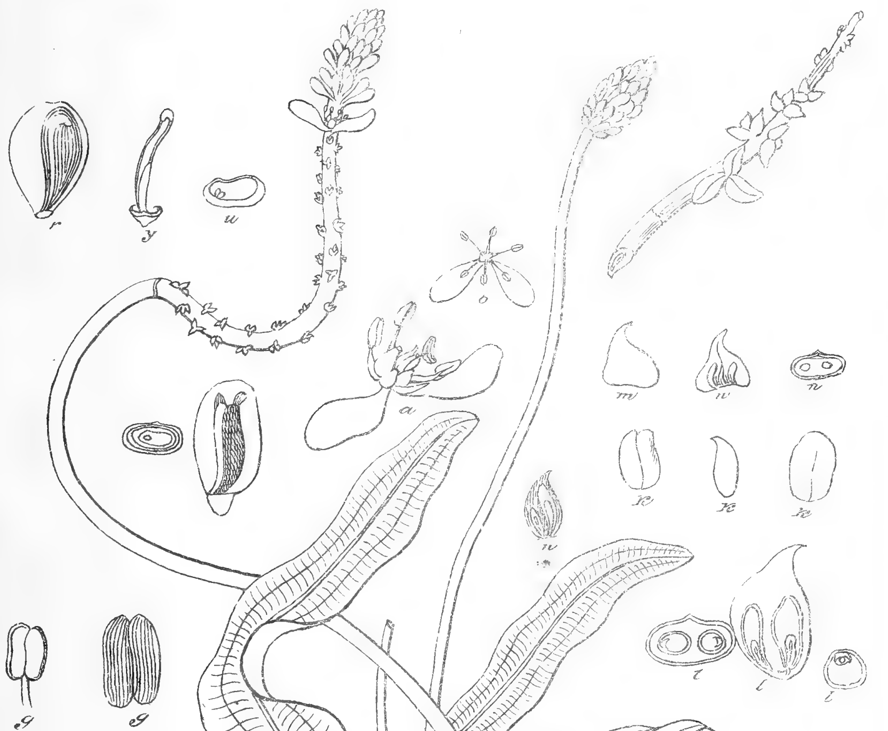
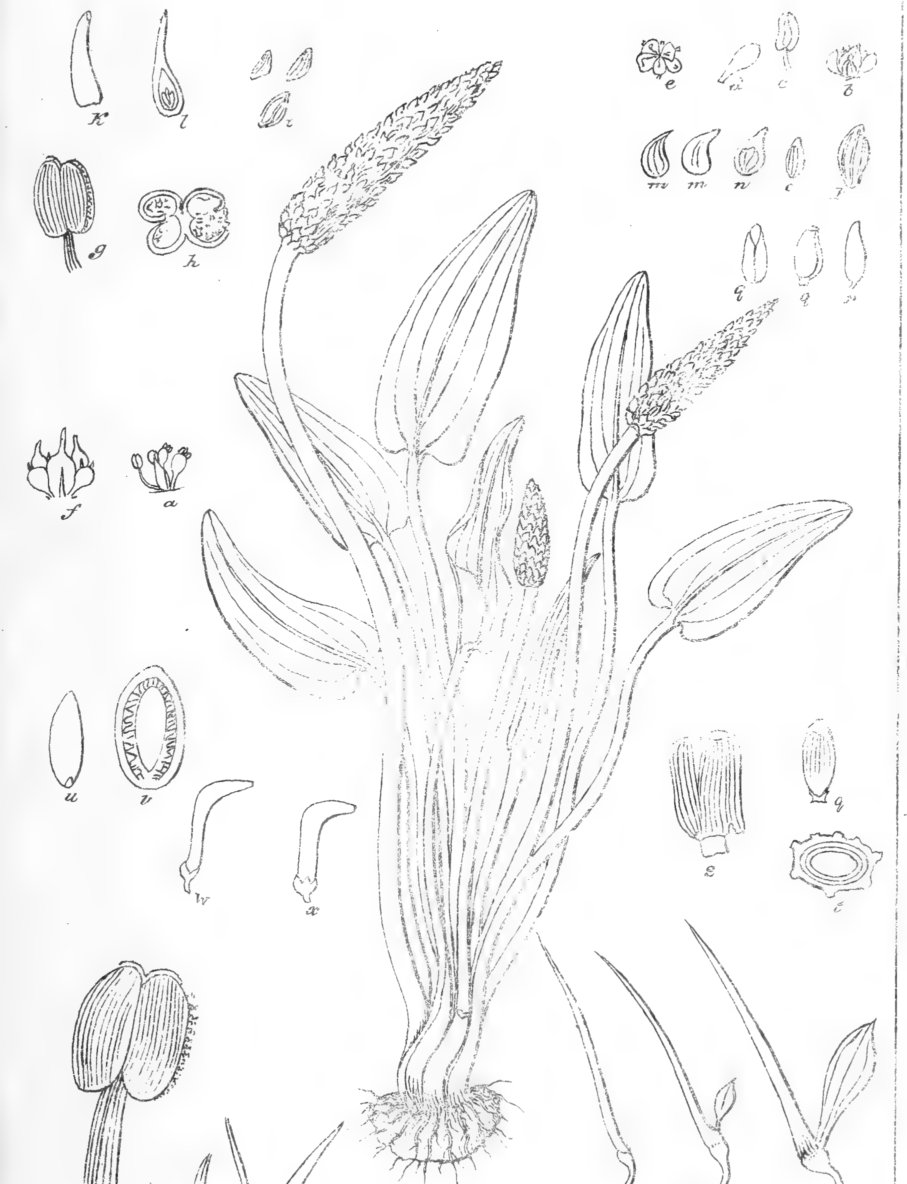
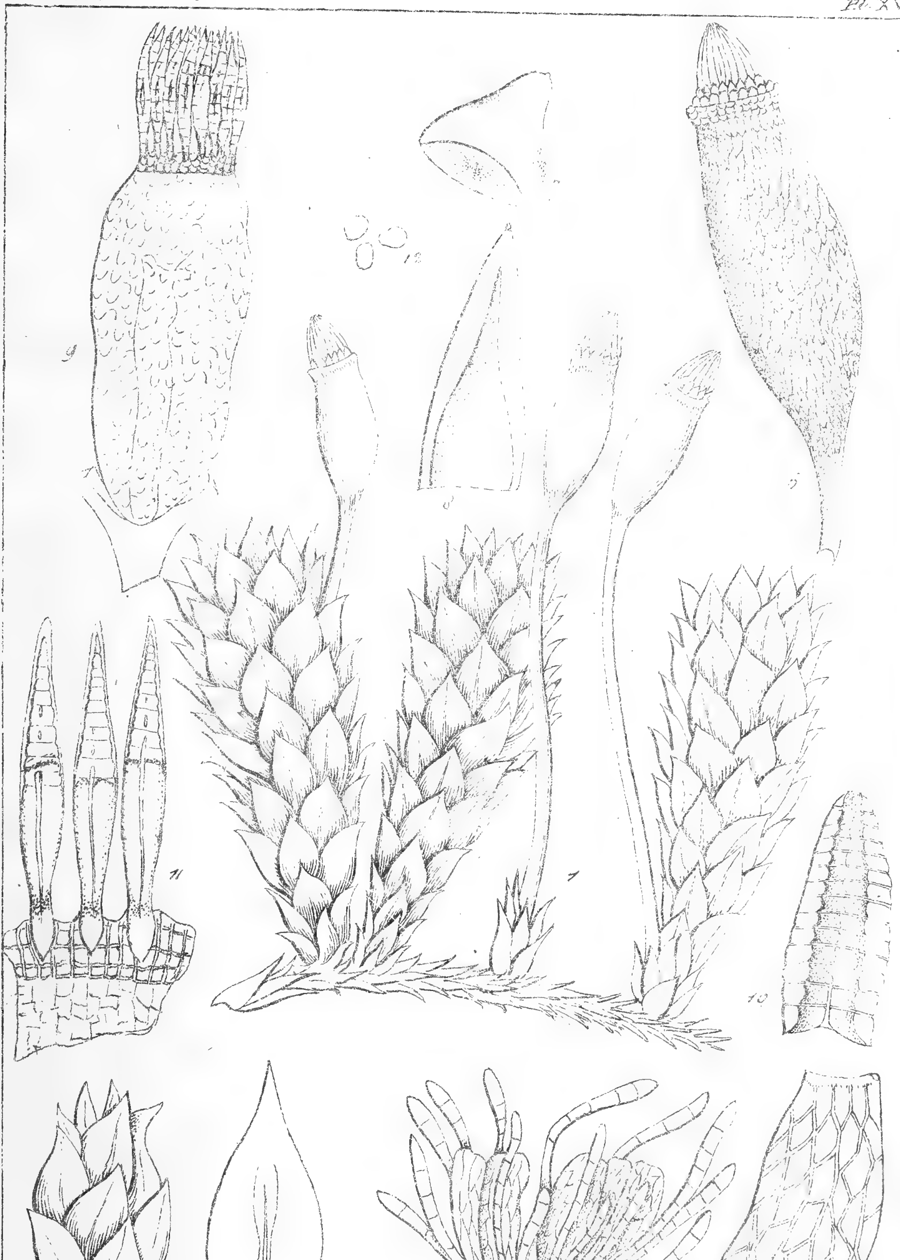


Spathium undulatum Edg with
Aponogeton undulatum. Rox bg

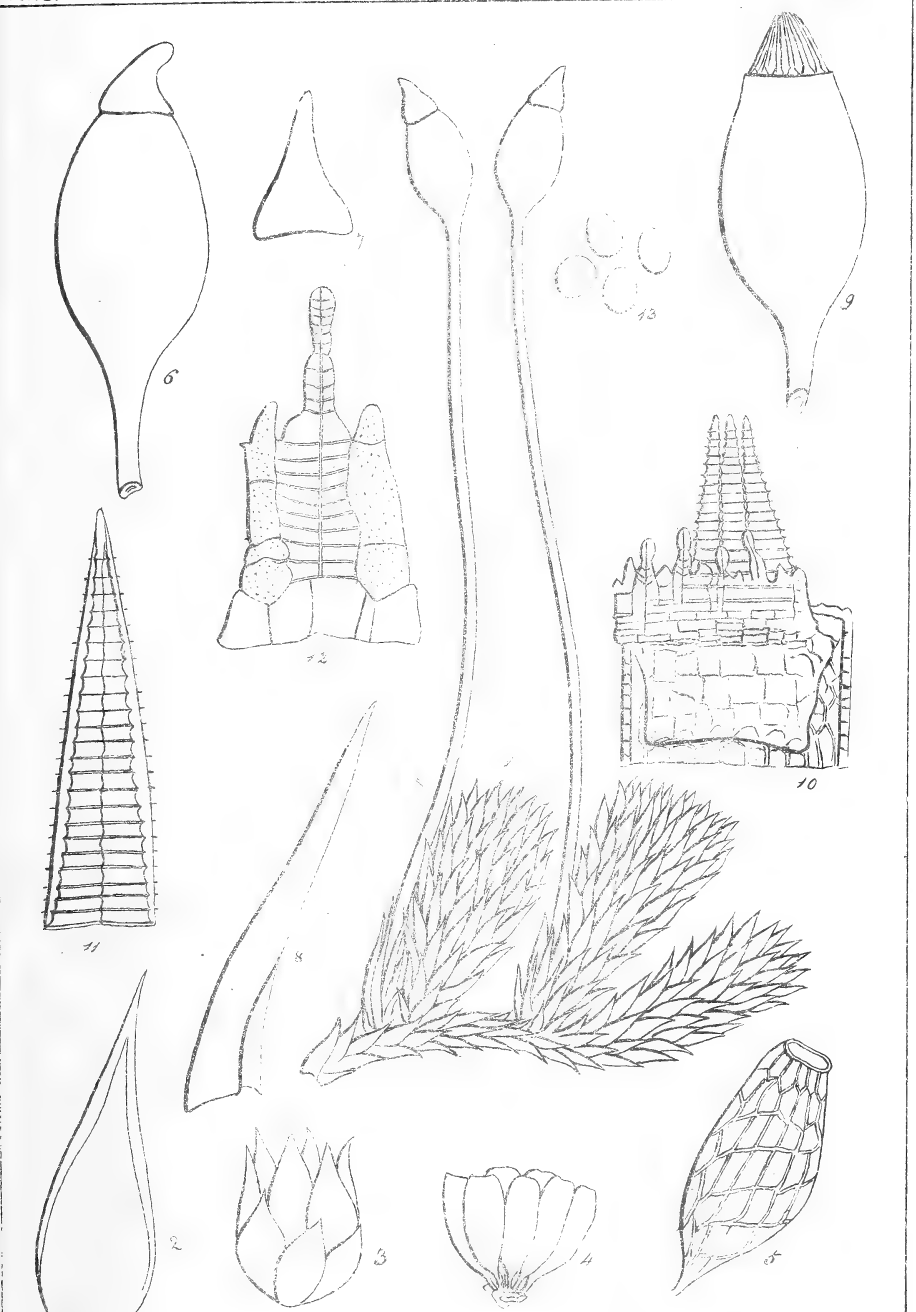
Part of leaf magnified to shew the nervation of the upper surface I could not deted any stomutæ.



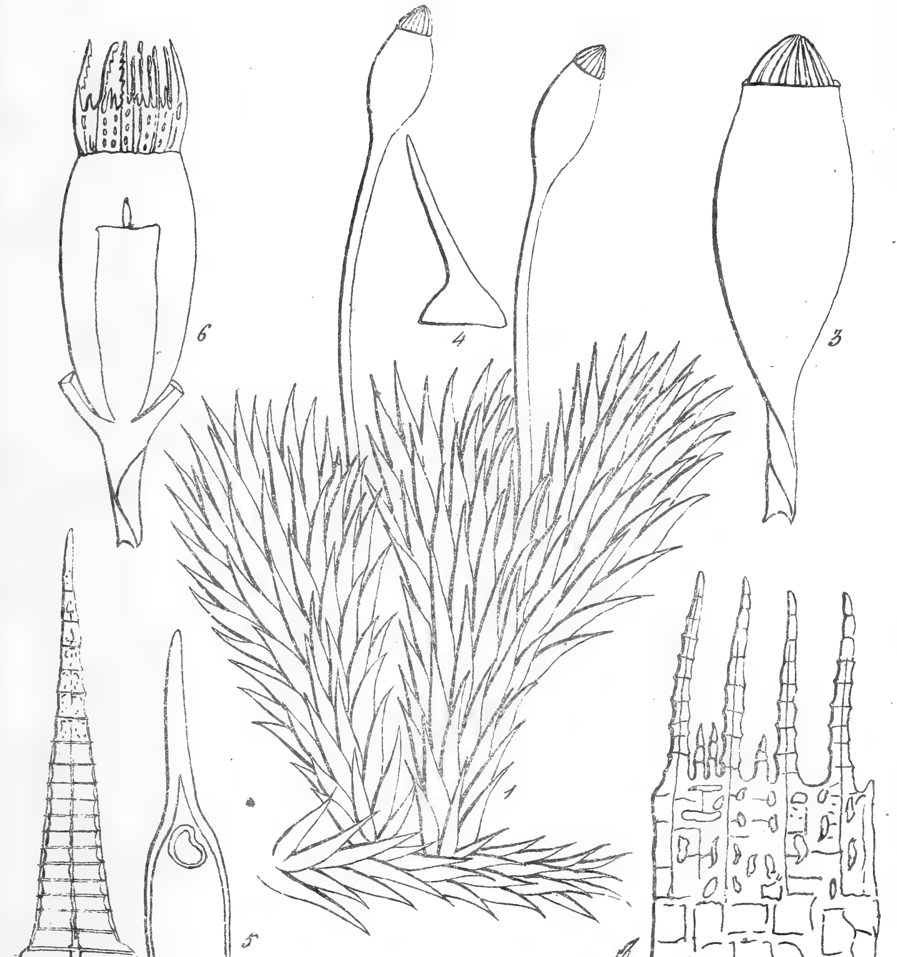
Spathium monostachys Edg.wth
Aponogeton ________? Rox.bg



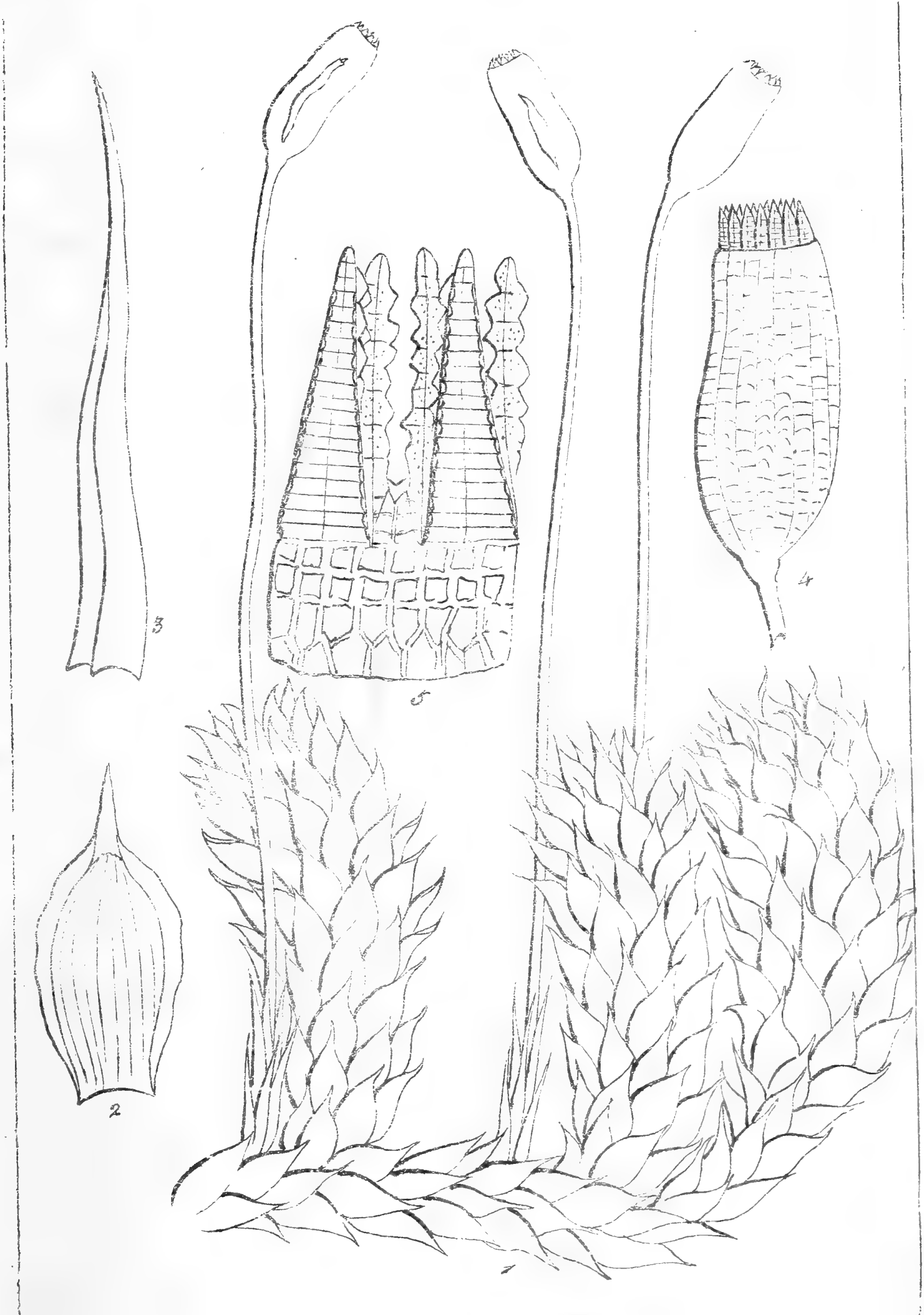
Anhymenium polycarpon =



Pleuropus dentous



Pleuropus fenestratus



Pleuropus pterogonioides